The science news monthly

SCIENCE DIGEST

DECEMBER 1965 35 CENTS ICD

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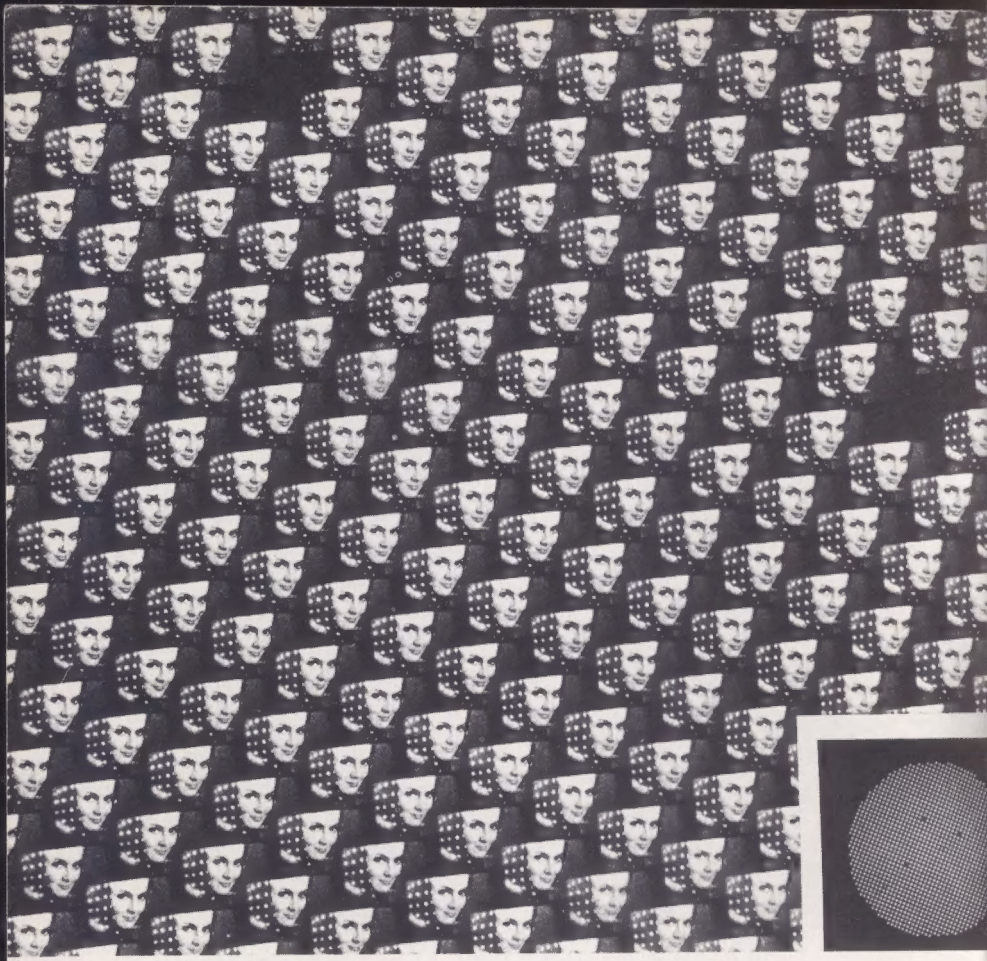

Fly's-eye photograph

THE multiple photograph of a girl's face (above) was made from the single negative shown at lower right. The picture was taken by the new one-and-a-quarter-inch "Fly's Eye" lens which is capable of producing more than 1,300 images with a single exposure.

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The lens was developed by International Business Machines Corp.

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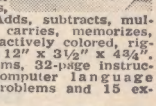

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THIS magazine is dedicated to the proposition that science today is everybody's business.

Two articles in this month's *Science Digest* remind us that we are living in an age when the greatest force in our culture is the pursuit of scientific truth about ourselves and our world.

THIS MONTH

One article is the story on M.I.T., the third in our series on America's top science schools. In it, President Julius A. Stratton points out that hardly any life work today does not require an understanding of technology. That is the reason behind a revolutionary change in M.I.T.'s curriculum initiated this fall, a change that will be felt for many years to come.

The other reminder of the all-enveloping influence of science in our lives appears in this month's article of comment, an excerpt from a remarkable new book by J. Bronowski of the Salk Institute for Biological Studies. Modern man is in a panic, he says, because his old values are dissolving in the light of new knowledge and he doesn't know where to turn. Bronowski suggests as an alternative the "code of values of science, which makes the pursuit of truth its first endeavor and an end in itself."

As one instrument in keeping everyman up-to-date on science, we commend these articles to you.

—THE EDITORS

SCIENCE DIGEST

The science news monthly

The most expensive sea shell in the world is the rare and beautiful Glory-of-the-Seas Cone. Recently one sold for $2,000. Other rare shells also fetch fancy prices. An expert's look at the wonderful world of shell-collecting begins on page 66.

Photo by R. T. Abbott.

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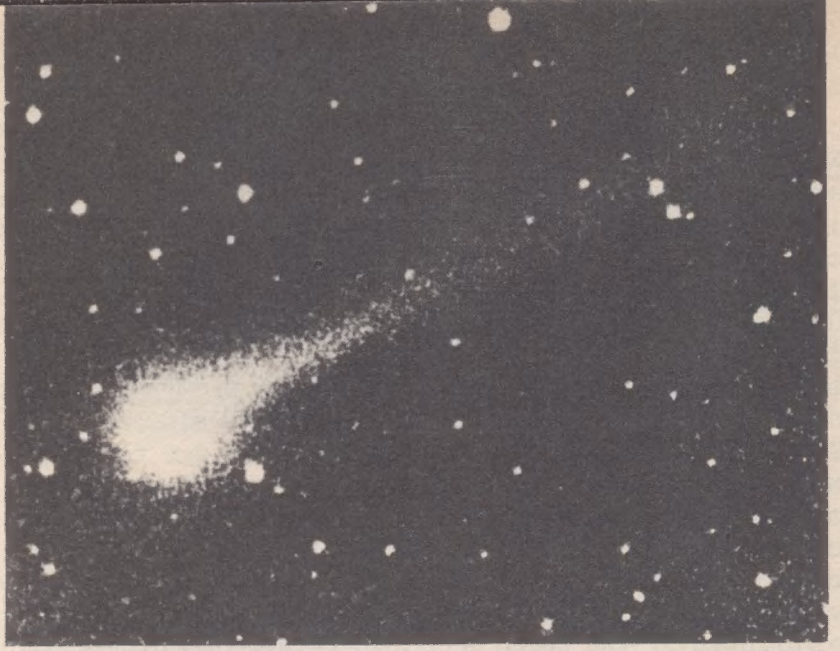
ALL THIS WILL FLY ..... Inside Back Cover

THE LATE SCIENCE NEWS

FALL OF STEADY STATE THEORY. British Astronomer Fred Hoyle, foremost proponent of the steady-state theory of the universe, has admitted that he may have been wrong for the last 20 years about how the universe began. His new views are much closer to the rival big bang theory. The reason for the switch is that observations of quasars indicate that the universe was much denser in the past than it is today. The steady-state theory predicts an even distribution of matter throughout the universe. Hoyle, however, has not abandoned all elements of the steady-state theory. For example, he still believes matter is being created in the universe.

HARD WAY TO SOFT LANDING. The third Soviet attempt to land a probe on the moon failed apparently because the braking rocket fired too soon. A similar U.S. project, Surveyor, is also running into difficulty. Models of the craft failed to pass preliminary tests and the date of the first shot has been set back at least until February. It was originally scheduled for late this year. NASA's associate administrator for space science and applications, Dr. Homer E. Newell, describes the project as "an unusually ambitious and difficult undertaking." The first four of the 17 projected Surveyor shots are engineering test models. They will investigate the problems involved in landing. A successful soft landing by any one of these four will be a welcome but unexpected bonus for the $530 million Surveyor program.



Wide World

"HAIRPIN" COMET. The newly sighted Ikeya-Seki comet (above) is thought to be the eighth in a family of sun-grazing comets in almost identical orbits. They whip around the sun in a dramatic hairpin turn that changes their direction in a matter of hours. In 1882 one of these comets passed so close to the sun it broke up into five parts. All these comets are believed to be parts of a giant comet that broke apart sometime in the distant past. The fragments take about 1,000 years to complete one orbit. The total number of fragments in this family is unknown.

MYSTERIOUS "MYSTERIUM". University of California radio telescopes have picked up signals from space so strange that astronomers call them "mysterium." The patterns on the radio spectrum are completely unlike those predicted in laboratory studies of elements and compounds expected in interstellar gas. They do not fit the pattern of any known substance.

WALK-IN-SPACE PLANS UPSET. NASA officials announced that plans for an untethered walk-in-space during the Gemini program have been canceled. A possible reason for the cancellation is that space officials feel that Gemini 4 astronauts McDivitt and White made two judgment errors during White's walk-in-space, and they question the ability of astronauts to make sound decisions in space. The errors were: the decision to go through with the walk after having so much trouble opening the spacecraft hatch and White's overstaying his scheduled 12 minutes outside of the ship. Future walks may employ a 200-foot-long lifeline which will allow astronauts to test a rocket-powered back-pack

ELECTRONIC PAIN KILLER. Electrodes implanted deep in a patient's brain may allow him to switch off terrible pain without doing any damage to his nerves or brain cells. The system, evolved by a psychiatrist-neurologist and a neurosurgeon at Harvard Medical School, may replace addicting drugs or radical nerve surgery for persons suffering the agony of cancer or other painful diseases. The electrodes are attached by fine wires to a white box about the size of a transistor radio.

HEAT FOR CANCER. An East German physicist claims that raising the body temperature to about 111 degrees during treatment lengthens the lives of cancer patients. The treatment is not envisioned as a cure but as a means of keeping the abnormal growth of cancer cells in check. Manfred von Ardenne, the physicist, says the treatments, followed by drugs, may allow cancer victims to live the controlled lives of diabetics and epileptics.

active men have a two to three times better chance of surviving a heart attack than less active men, and a better chance of escaping the attack in the first place. . . . Oral contraceptives may induce neurological complications, including even strokes, in some young women especially those with family history of abnormal clotting or strokes.

HAY FEVER SHOTS WORK. A carefully controlled test at Massachusetts General Hospital has demonstrated that injections for ragweed hay fever really reduce symptoms. For a long time many doctors have been uncomfortable about the shots since tests did not show whether injection or wishful thinking caused hay fever sufferers to feel better.

FLU, GERMAN MEASLES DRUG. A University of Michigan medical researcher announced that two new experimental drugs show great promise of preventing many types of flu and German measles. The drugs are not now available in prescriptions and are still being tested.

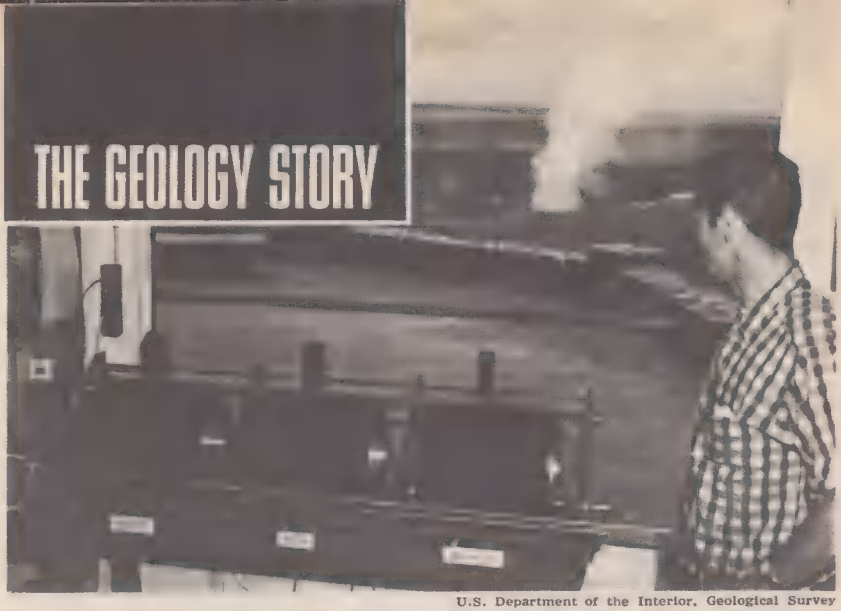
DIET SWEETENER CONTROVERSY. A preliminary British report that one type of artificial sweetener has reduced the growth rate of laboratory rats threatens to reopen the question of the safety of sugar substitutes.

WALK-IN-SPACE PLANS UPSET. NASA officials announced that plans for an untethered walk-in-space during the Gemini program have been canceled. A possible reason for the cancellation is that space officials feel that Gemini 4 astronauts McDivitt and White made two judgment errors during White's walk-in-space, and they question the ability of astronauts to make sound decisions in space.

DETECT UNDERGROUND ATOM TEST. A new American detection station in Montana clearly recorded signals from a relatively large underground nuclear explosion in Soviet Central Asia, 5,700 miles away. The explosion provided the first real test for the most elaborate and sensitive seismic station yet built in the U.S. for detecting underground explosions.

SUBMERGED CONTINENTS. If the continental drift theory is true, then there must be some Texas-sized submerged "microcontinents" in the Atlantic and Indian ocean. Oceanographer Robert Dietz proposes a project to find them.

QUOTE OF THE MONTH: "The ocean is a much more hostile environment than space. I worked much harder in Sealab 2 than in the Mercury capsule. More energy is required just to move around, because of the extreme pressure, and just to stay warm, because of the 50-degree cold. But the real key is the isolation. I think men can live as long in underwater habitats as they can in Dewline stations or any place else where they are isolated. I am convinced that men can live and work forever--any length of time they wish--beneath the surface of the ocean."--Astronaut M. SCOTT CARPENTER, after spending 30 days on the floor of the Pacific Ocean in the Navy's Sealab 2.



U.S. Department of the Interior, Geological Survey

Geologists and instruments at the Geological Survey's Hawaiian Volcano Observatory can constantly keep watch over the steaming crater of Kilauea Volcano, Hawaii.

The most dangerous science

by Bruce H. Frisch

TRYING to outwit a volcano can be dangerous. In September a team of Philippine government experts stationed on Mount Taal lost their lives for lack of foresight. During a sudden eruption, the crater opened up, a witness reported, "and swallowed everything—office, typewriters, seismographs, desk and charts."

The danger is greater, because volcano forecasters have never been kibitzers. In 1929, Frank Perret was recuperating in Puerto Rico from near physical and nervous collapse caused partly by breathing volcanic fumes for 27 years. But the lure of new rumblings from Mont Pelée on Martinique farther down the Antilles was too great.

Perret arrived to find the inhabitants near panic. With one flaming cloud Pelée had wiped out the city of St. Pierre in 1902. The skittish populace of the new St. Pierre was closing down factories and leaving the sugar cane unharvested. Give him a week, said Perret, and he trudged up the mountain equipped with only his experience and a microphone that he pressed to the ground.

The modern picture of a volcano is of a mountain connected to a chamber about three miles underground, which is in turn piped to a source chamber about 25 miles down. The hot rock paste called magma stirring in the lower chamber hammers out major earthquakes. Churning magma in the upper chamber causes minor

quakes. As the magma rushes through conduits from the upper chamber to the surface, it jostles the earth slightly. Today's volcanologists pick up the faint tremors on a net of seismographs that tells them where as well as when lava will gush forth. Perret listened.

At the end of the week he came down the mountainside to report. The plug in the crater of Pelée was open. The volcano would not blow its top the way it had in 1902. The grateful people showered him with medals, kisses and an observatory.

Perret seemed to have a knack for carrying good news. Earlier in his career he was dispatched to gauge an eruption of Stromboli, a volcanic island near Sicily. Five Italian warships waited to evacuate the island at his word. "The eruptions to come will be less dangerous," he told them. "I am going to stay right here and see it. There is no need for the people to leave."

Perret, an American, got his start at the observatory established in 1845 on Mt. Vesuvius near Naples. The place was still there in 1944 when the Allies fought their way up the Italian peninsula. A detachment of weathermen took over the building, shunting director Guiseppe Imbo into one room and stripping him of all authority. Then Vesuvius came to life, and Imbo's status soared. The eruption also revived the historic Neopolitan April Fool's Day joke of lighting a bonfire on the crater rim.

Present-day volcanologists come better equipped than Perret was. Two years ago Costa Ricans called Haroun Tazieff from the U. of Brussels to size up menacing Irazú. Wearing a gas mask, asbestos suit and fiberglass armor to ward off flying bombs, Tazieff advanced into the fuming crater. He planted portable seismographs and plunged glass tubes into the ash to collect gas samples. An increasing flow of hydrochloric acid gas is often a tipoff of a coming eruption.

Road to the brink

Shirt-sleeved spectators could get almost as close, since a tourist road ran to the brink of the crater. Tazieff recommended that the road be closed, but was ignored. Later, a minor volcanic burp killed two, injured ten.

Tazieff's main warning: Watch out for rain. Whole villages at the bottom of 7,000-foot Mayon volcano in the Philippines have been buried in mud after typhoons soaked the mountain of ash.

Perret was the Johnny Appleseed of volcanology. Before setting up the Pelée observatory he had started one for M.I.T. on Kilauea in Hawaii. The U.S. Geological Survey took it over later.

Most of the observatory's battery of instruments is for detecting the level of the magma. As magma rises toward the surface it changes the local value of gravity, the earth's magnetic field and the electric currents in the ground. It builds up pressure underground, blowing up the mountain like a balloon. A tilt-

UPI Photo

Taal volcano still erupts while this family unloads some of their salvaged belongings.

meter, a sensitive version of the carpenter's level, gives a reading.

Putting all the signs together, the staff urged the evacuation of the town of Kapaho in 1960, hours before a lava fountain spouted out of a papaya patch.

Long-time director T. A. Jaggar predicted the 1935 eruption of Mauna Loa four years in advance. After a month of eruptions a thirty-foot-high wall of lava was advancing a mile a day toward the port of Hilo.

Jaggar went into a huddle with Army officers. The tops and sides of the flow had crusted over, holding in heat and keeping the center hot and liquid. Jaggar urged bombing. Four days later ten bombers (in those days each bomber carried only two 600-pound demolition bombs) struck at the lava tunnel high up the mountain. They clogged the tunnel and exposed the liquid stream, which then solidified right back to the outpouring vent. By that evening the lava wall had stopped.

In other places walls and bulldozed mounds of dirt have been used to divert a lava flow. Villagers in Java have heaped artificial hills among their flat farms to serve as islands of refuge during a lava flood.

The latest weapon against volcanoes is aerial infrared photography. Hot spots show up bright. Brightening spots on a series of photographs of Kilauea have located eruptions that occurred six months later.

Similarly, a rise in the temperature of hot springs often indicates approaching activity.

During the year preceding the Taal disaster, the 10-mile-long lake surrounding the volcanic island went from 86 to 115 degrees F. Yet, having received no warning, islanders held a fiesta that swelled the population from its normal 1,000 to a possible 6,000 on the night of Sept. 28. At two the next morning a Philippine Airlines pilot saw a fireball 10,000 feet high blossom out of the side of the mountain. Rescue teams the next day found no one alive, but the secret of exactly how many were killed is hidden under a layer of mud and ash.

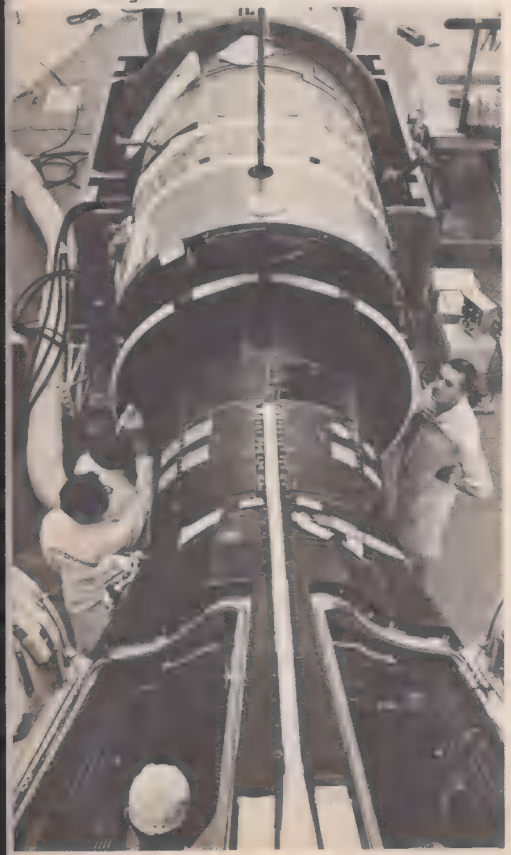
Such are the stakes in this battle of wits that science, as yet, cannot always win.

THE SPACE PICTURE

Biggest of them all

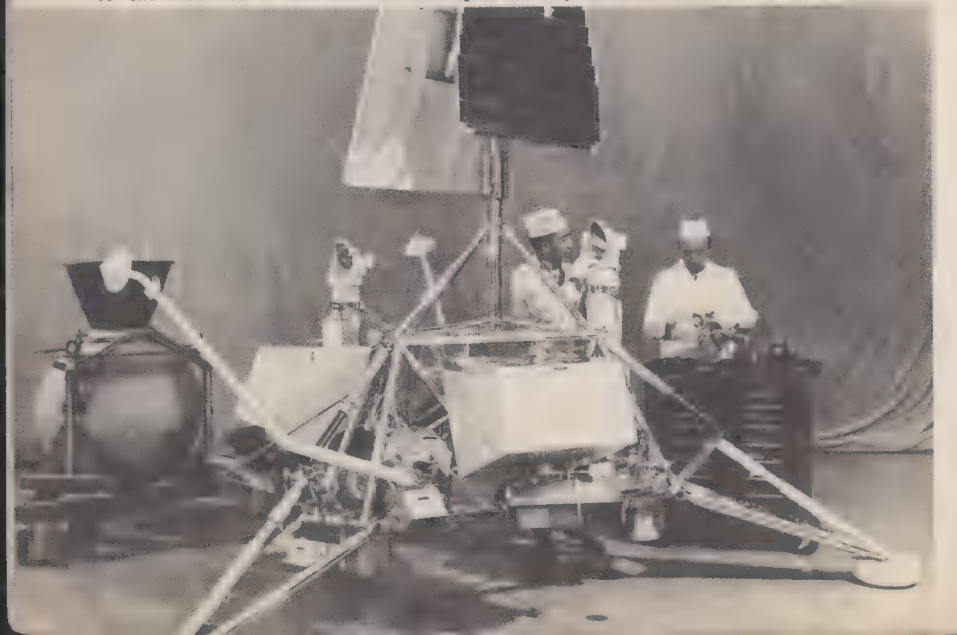
The first Saturn V flight booster is rolled out for a viewing at Huntsville, Ala. This stage—138 feet long and 33 feet in diameter—will power Apollo moon shot.

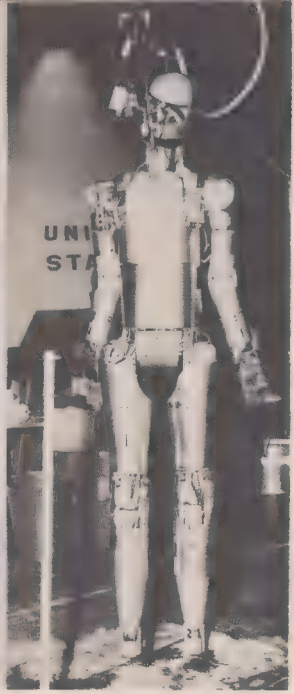
The Gemini VI spacecraft is given an earth-bound docking test before unsuccessful launch. Rendezvous between craft and target was to be a vital mission task.



Walter M. Schirra, sits atop practice Gemini space capsule floating in Gulf of Mexico. It's all part of the astronauts' rigorous and continuing training program. Even veterans like Schirra must practice their skill in leaving a capsule after splashdown.

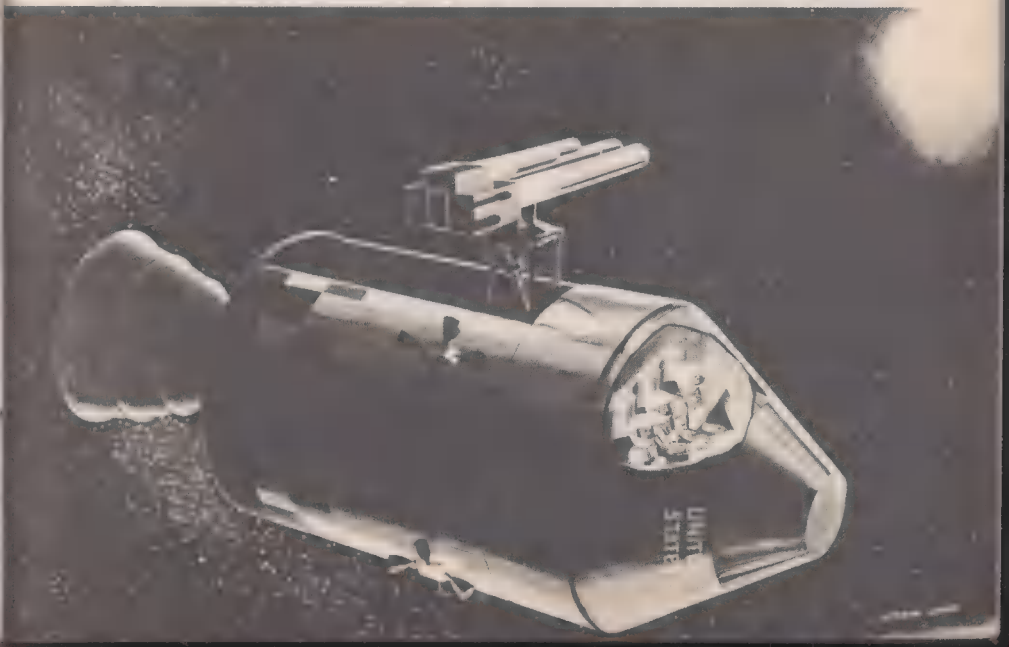
Engineers assemble Surveyor spacecraft designed for a soft landing on the lunar surface. At left is the huge retrorocket that is needed to slow the spacecraft on its approach to the moon so it will not be destroyed on impact and can send back information.





This robot (front view, left; rear view, center) is capable of simulating 35 human motions and helps designers evaluate space suit mobility. Right: Astronaut David R. Scott, who is scheduled to take a "walk around the world" during Gemini VII mission in '66.

Artist's conception of a solar telescope for a proposed earth-orbiting Apollo. The system would put a telescope at an altitude that would free it of most distortions that hamper ground-based observers. Astronauts would be on hand to make adjustments.



Now—A-blasts for cancer

by Arthur J. Snider

AT ARGONNE National Laboratory, the atomic energy installation near Chicago, a medical scientist is trying to destroy cancers by literally creating atomic explosions within the tumor cells.

The tumor is encouraged to absorb and accumulate a compound containing uranium-235, the fissionable material in atomic bombs.

A beam of neutrons—the projectile used to set off atomic reactions—is then directed at the uranium-laden tumors, causing them to undergo fission. They explode into fragments and release more neutrons.

The split fragments zip through adjacent tumor cells, destroying or damaging them so badly that death ensues. Normal tissue, containing no fissionable uranium, is not harmed.

As the fission fragments come to rest, they decay and give off charged particles in the form of beta and gamma rays and an occasional neutron. To some extent these smaller particles help destroy the tumor but over 90 percent of the lethal damage is done by the fragments.

"Roughly speaking, the fission fragments represent an energy on the order of magnitude of an atomic bomb while the other particles more nearly resemble rifle bullets, explains Dr. Norman A. Frigerio, who combines the backgrounds of chemistry and physics with medical science.

While the work at present is limited to animals, he is hopeful it will reach the clinical stage in this decade.

The idea of "neutron capture" as a treatment is not new. Physicians at Brookhaven National Laboratory and Massachusetts General Hospital tried it without success in 1958. At that time the type of neutrons available did not penetrate sufficiently. Furthermore, boron was used as fissionable material, yielding only about one-twelfth the radiation energy of uranium.

These problems are largely solved but there remains the bottleneck of a suitable injectable carrier to trans-

port the uranium to the tumor. Uranium would be much too toxic to use alone and would not localize in the tumor anyway.

Dr. Frigerio and his associates have found a compound that has a special affinity for tumors but with one serious drawback. It turns the experimental white mice a permanent deep blue.

The compound also has a tendency to make the animal photosensitive. If exposed to ordinary light, the animal would be "sunburned" to death.

"We are, therefore seeking U-235 compounds without these effects," Dr. Frigerio says. "We have a number of compounds that are colorless, do not photosensitize, are nontoxic and localize well but as yet we have no U-235-containing versions that we are prepared to use on human patients."

Studies thus far indicate that good localization can be obtained in tumors almost anywhere in the body—except for the liver, kidney and spleen—by using certain modified blood serum proteins as carriers. This is not surprising since it has long been known that serum proteins tend to localize wherever there is an inflammation.

Thus, the exciting possibility exists that cancers that have spread beyond their original site to other parts of the body also might be treated.

Uranium-235 has the added advantage of emitting a weak gamma ray that can be picked up by scanners. Once the U-235 compound has been injected, the gamma ray would provide a road map telling the therapist where localization was taking place and permitting him to hit it with a neutron beam at just the right time.

Early diabetes signs

Diabetes may show itself in the form of diseases of the eye, kidney, blood vessels, skin or feet long before the classic picture of too much glucose in the blood or urine develops, according to Dr. Max Ellenberg, associate attending physician, Mt. Sinai Hospital, New York.

These early symptoms are so ubiquitous, he points out in a diabetes newsletter published by The Upjohn Company, that all doctors in the field of medicine have the challenge to recognize diabetes in its earliest stage. A doctor should not wait until the overt symptoms of diabetes appear, he said.

Among the warning signs:

- The appearance of glaucoma, cataracts or retinal abnormalities in the eye.
- Coronary arteriosclerosis and thrombosis should, especially in women, arouse suspicions of diabetes.
- A kidney lesion of unexplained origin, especially if it is associated with absence of ankle jerks.
- Urinary tract infections, bladder dysfunction, ulcers on the sole of the foot.
- An unexplained stillbirth, an extra large baby or congenital abnormality.

Window for the blind

A tiny plastic "window" has restored sight to the blinded eyes of 61 persons at Columbia University, New York. Some of them were blind in both eyes.

Dr. Hernando Cardona of the Institute of Ophthalmology, Columbia-Presbyterian Medical Center, says the prosthesis is helpful for persons whose immune reactions reject a transplanted natural cornea from another individual's eye or who for some other reason cannot be helped by a corneal transplant. It is not helpful for persons with glaucoma, cataracts or retinal defects.

The 61 persons represent the successes on the first 100 patients reported on by Dr. Cardona. In 21 failures, the plastic implant has remained in place but there was no improvement in vision because of other eye defects. In 18 cases, the artificial implant did not remain fixed.

For almost 200 years, medical men have sought an artificial replacement for the eye's cornea, the thin, transparent outermost membrane covering the iris and pupil. But intense interest did not develop until the late 1940's when it was discovered that World War II fliers were walking about comfortably with tiny bits of plastic embedded in the eye as a result of shattered plexiglass cockpit canopies.

Scores of materials have been tried but the common failing has been a tendency to extrude or to irritate the eye.

The plastic implant developed by Dr. Cardona is about the shape of an eraser at the end of a pencil but is eight times smaller. The implant operation takes about 20 minutes. A hole the size of the implant shaft (1.5 millimeters in diameter) is cut through the center of the defective cornea. The implant is slipped into the hole and held in place by its flanges between two corneal layers.

Dr. Cardona manufactures his own polymerized plastic and tests it in a rabbit's eye for six months to be sure each new batch of chemicals is pure and free from irritating substances.

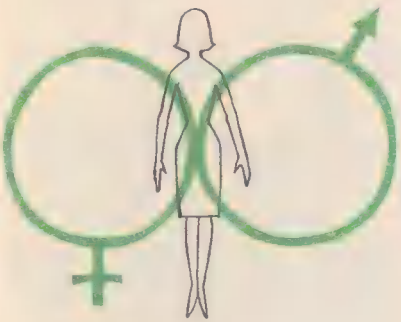
Sex hormone aids bones

Estrogen, the sex hormone that makes a girl a girl and promises to keep older women younger, now appears to have registered another favorable attribute. It delays the development of osteoporosis, the loss of bone mass.

Dr. M. Edward Davis, chairman of the department of obstetrics and gynecology, University of Chicago, calls the practice of supplementing a woman's deficient estrogen supply "an exciting area of preventive medicine."

He recently reported on a long-term follow-up of post-menopausal women who have been on replacement estrogen. They showed significantly greater retention of bone density than an untreated group used as a control.

"Post-menopausal osteoporosis is a physical change, an aging phenomenom," Dr. Davis says. "It is not a disease. It is the most common metabolic disorder of the bone and is an inevitable sequel to the disappearance of estrogen production."



As the aging woman becomes less active, the stress and strain stimuli to bone formation is decreased. More bone is absorbed than is formed. Bone mass gradually decreases.

Men are spared the process of decreasing bone mass for their gonads continue to produce hormones for most of their lives. However, even in men the decrease in physical activity in later years can bring on senile osteoporosis.

Dr. Davis' interest in osteoporosis, which affects about four million persons in the United States, began when he started giving estrogens to women whose ovaries had to be removed.

As these women returned for examination year after year, before and after menopause, he found they seemed to age much less rapidly and develop less hardening of the arteries. Additionally and unexpectedly, they also developed less osteoporosis.

"Giving estrogens only to relieve symptoms of menopause is archaic," Dr. Davis believes. These hormones are "far more rewarding" in retarding the general physical changes that usually accompany aging, he says, adding:

"This is an exciting area of preventive medicine that will help our women to retain their good health in their advancing years."

The fat ex-smoker

A man quits smoking cigarettes in the hope of avoiding lung cancer; but he finds he is gaining weight, another hazard. Which is worse?

A physician posed the question in the *Journal of the American Medical Association* and received three replies.

Dr. Jean Mayer of the Harvard School of Public Health says it is advantageous to stop smoking even at the risk of gaining some weight. He continues:

"A well-known statistician has said he estimates it would take a weight gain of more than 120 pounds to offset the effect on longevity of two packs of cigarets a day."

Another physician to whom the question was referred, Dr. Abraham Kagan of Honolulu, tended to agree. He said that the potential

disadvantages from obesity, including increased blood pressure, diabetes and agina pectoris, are more than offset by the lower chance of death from heart attack and lung cancer to be derived from stopping smoking.

However, Stanley Schor, director of the AMA department of biostatistics, said studies on the point are confusing. Some show that people who smoke up to 10 cigarets a day have the same excess mortality as people who are 30 percent overweight. Other studies show just the opposite. Says Schor: "The prudent man will not allow himself to gain weight when giving up cigarets."

Jolts for alcoholics

Placed in front of the alcoholic patient are six small plastic cups filled with milk, water, fruit juice, beer, wine and whiskey. If he chooses among the latter three, he gets a powerful electric jolt as he swallows.

The aim of the "aversive therapy" is to help alcoholics by teaching them to associate drinking with an unpleasant experience, explains Dr. John J. Hsu, director of research at Pontiac State Hospital.

The shock is provided by electrodes placed on the patient's head.

Among the 40 male alcoholics who volunteered for treatment, 13 improved enough to seek employment, Dr. Hsu said. He adds, however, that it is too early to evaluate the permanent effectiveness of the treatment.

Those who gave up the treatment, he adds, showed a very low tolerance to pain or seemed to fear being unable to drink again if they completed the treatment.

Those who were successfully conditioned reported that the sight of alcohol or the idea of drinking brought on unpleasant bodily responses, such as nausea.

Beatle-cut troubles

The Beatle-type haircut is creating a forehead skin problem, says Dr. Lewis Kirkham, Salt Lake City dermatologist. He points out that as the hair becomes dirty, it collects bacteria and promotes development of skin disease, particularly acne.

As a treatment, Dr. Kirkham directs the young patients to first get the hair cut off their faces. They are then directed to wash their hair every day and use a non-oily hair dressing.

PERSONALITY OF THE MONTH

Everybody's scientist

DR. WARREN Weaver (above) recently became the first winner of the Arches of Science Award of the Pacific Center Foundation, Seattle, Wash.

This new award is called "an American Nobel Prize." It consists of a cash prize of $25,000 and a gold medal. It was created to recognize outstanding contributions by an individual to the understanding in America of the meaning of science.

How does one go about doing that?

Dr. Weaver, for one thing, does it by being an admirer of his fellow mathematician and writer, the late Rev. Charles Lutwidge Dodgson, better known as Lewis Carroll.

He is one of the world's great authorities on Carroll's *Alice in Wonderland* and wrote the book *Alice in Many Tongues*, devoted to the translations of *Alice* in different languages around the world.

Dr. Weaver's appreciation for language has had a special significance beyond the purely literary. It was he who first suggested the idea that has become the basis of all mechanical language translation. The idea was to seek out the elements common to all languages.

The conceptual talents of Dr. Weaver reach higher than that, however, on the technical plane. He is an internationally-known mathematician whose forte is the theory of probability and statistics.

That's what Dr. Weaver *is*. What he *has done* to win this "American Nobel Prize" for the first time has been (as he reminded reporters recently) to give away $50 million of someone else's money—the Rockefeller Foundation's. For 28 years, Dr. Weaver was an associate of the foundation whose efforts helped to set the stage for the decoding of the gene and the rationalization of the physiochemical machinery of the living cell—one of the most important research movements now under way in science (see page 40).

Dr. Weaver is now a consultant and trustee of the Alfred P. Sloan

Foundation.

He has also taken part in the organization and policy-making of the National Science Foundation and the Sloan-Kettering Institute and he is chairman of the board of the Salk Institute for Biological Studies.

Radiation chairman

In 1955, when popular concern about the hazards of high-energy radiation verged on panic, Dr. Weaver was named chairman of a committee of 15 geneticists to study the problem of radiation. He wrote the committee's report, "The Biological Effects of Atomic Radiation," which got world-wide recognition.

Warren Weaver was born in Reedsburg, Wisconsin, in 1894. He received his formal education at the University of Wisconsin and began teaching mathematics at Throop College (now the California Institute of Technology). In 1920, he joined the math department of the University of Wisconsin. He was made chairman of the department in 1928.

Dr. Weaver got into the area of communicating science to the public back in 1943 when he was named chairman of a committee that developed the radio series, "The Scientists Speak." The program ran for two years, and featured 12-minute talks by eminent scientists during the intermission of the New York Philharmonic Symphony broadcasts over the CBS radio network.

Since that time he has helped create the Public Understanding of Science Program of the National Science Foundation, the Advanced Science Writing Program at Columbia University and the Council for the Advancement of Science Writing. He is also a member of the board of the Scientist's Institute for Public Information.

Dr. Weaver has written more than 100 articles on mathematics and physics and interpretive articles about science. He is also the author of several books, including the popular *Lady Luck—The Theory of Probability*.

When Dwight D. Eisenhower was President, he asked leading Americans for statements of the nation's goal to be included in a volume entitled, *Goals for Americans*. Dr. Weaver wrote the chapter, "A Great Age for Science."

It is an age he helped bring about.

"Fire nothing! You've discovered smoke!"

Smith Kline & French Laboratories

Army of the lost

by Flora Rheta Schreiber and Melvin Herman

NEW YORK City alone has 25,000 narcotic addicts. They must borrow, steal or prostitute themselves to raise $700,000 a day to support their habit.

With somewhat altered, although still frighteningly high statistics, we can write ditto for Chicago, Los Angeles and Detroit. Add to these the many thousands of addicts who do not get into the statistics, some who avoid being counted because they can afford their habit, and the mounting number of drug users is almost unbelievable.

This army of the lost includes all social classes and all age groups, beginning with the elementary school child. Whatever the motivation, whatever the root cause, all these persons pursue the path of desperation, devoid of hope and meaning.

Why? Various recent developments provide some answers. The 1914 Harrison Act provides federal narcotic regulation. Along with subsequent narcotic laws, it included marijuana among the narcotics. This inclusion is contested today, particularly by the Bohemian set, which argues that the use of marijuana is perhaps even less questionable than the cigarette habit, especially so in this age of cancer scares. The laws, however, with no bow to Bohemia, continue to list five groups of drug abusers, those who take 1. opium and derivatives, 2. coca leaves and derivatives, 3. marijuana, 4. the meperidine groups, and 5. opiates (other addiction-forming substances).

Drug abusers usually seek an artificial means to escape problems, reality.

The effect of the drug is, of course, the core of the problem. The compounds mentioned, with the exception of cocaine and marijuana, can produce morphine-like physical dependency and withdrawal symptoms. The effect of morphine is, in fact, the criterion for new drug evaluation in terms of whether they produce morphine-like dependence.

Chronic use of any of these drugs may lead to physical dependence, but it is the psychological dependence that evolves from habitual use that is an even graver problem. The nature and degree of psychological dependency is, of course, related to the personality of the user. Some persons are prone to such dependency, not through the direct effect of the drug for sedation or stimulation, but rather through euphoria that implements an escape from reality. Often they use the drug to "solve" life's problems.

While drug abusers naturally differ from each other in an emotional sense, they are likely to have histories of social maladjustment, to suffer from personality disorders and to break under the pressures and demands of life. They are alike, too, in seeking an artificial means to escape reality. Curiously, too, the habit may start innocently. For many a young boy or girl, the beginning is a dare, taken in order to do as the group does—to belong. Belonging through association with other drug abusers later becomes an important element in fostering and sustaining the dependency.

The influence of personality type on drug response has been investigated by Alvin L. Frostad and Gary L. Forrest, research fellows in psychiatry, and Cornelis B. Bakker, M.D., assistant professor of psychiatry, all of the University of Washington School of Medicine, Seattle. Their conclusion:

"Action-oriented people respond differently from non-action-oriented people."

Methodology

The major significance of the study lies in the development of a methodology by which it will be possible to establish in which way different personality types respond to different kinds of drugs. As this and similar studies proceed, the effects of specific drugs will emerge more clearly, not only on patients who must have them for medical reasons, but also on abusers whose "must" is, in its way, as urgent.

Each drug has its own syndrome of effects and inherent dangers.

Barbiturates depress the central nervous system and are medically used for a variety of sedative actions. They induce sleep, have a steadying, calming effect, lessen anxiety and go to work lowering high blood pressure. They also are used to increase the effect of pain-killing drugs.

But at the same time barbitur-

ates may be more dangerous than narcotics, since both tolerance and physical dependence on them are often concomitants. When barbiturates and alcohol are taken together, they can produce "a cheap drunk." An unconscious, apparent drunk may be in such a state. Mistaken for a simple drunk and denied the necessary medical treatment, he might die.

Physical dependence

Another danger in excessive doses of barbiturates is physical dependence, with attendant withdrawal symptoms. Significantly, these barbiturate withdrawal symptoms are usually far more dangerous than similar symptoms resulting from narcotic withdrawal.

The excessive use of even mild tranquilizers has built-in dangers. The psychic and physical dependence they produce is similar to that evoked by barbiturates. Paradoxically, however, the more potent tranquilizers, including the phenothirazines and reserpine, do NOT cause dependency. They also have little, if any, potential for abuse.

Among the drugs classified as stimulants, the prime targets for abuse are amphetamine and other closely related drugs. These drugs, which directly affect the central nervous system, produce excitation, alertness, wakefulness, and sometimes a temporary rise in blood pressure and respiration. They have a wide application in current medical practice. Millions of people take them under medical supervision and for long periods of time with no ill effects. These drugs have been used for many years in the treatment of mental diseases and for seriously overweight persons. Amphetamine appears to exert a specific effect on the appetite center in the brain and also improves the patient's mood. These twin effects lessen the psychic dependence on food.

But—and the "but" is crucial—excessive daily doses c a n cause drug psychosis, resembling schizophrenia. This drug-induced psychosis is characterized by delusions and hallucinations, both visual and auditory.

Perhaps the favorite hunting ground of drug abusers is not barbiturates, mild tranquilizers, or stimulants, but the hallucinogens. LSD (described in "Inside Psychiatry Today," Aug., '65) is the most potent. For centuries, Indian tribes used a hallucinogen, mescaline, extracted from cactus (peyote) in religious ceremonies. Today, peyote is available to drug abusers in the form of "buttons," the dried seeds of the cactus. Happily, the hallucinogenic drugs are not addictive. But unhappily, they have become an important element in the wider pattern of drug abuse that includes narcotics, amphetamine, barbiturates and alcohol.

The drug thrill seekers, the proponents of kicks, the hell-bent-for-a-binge set, will use any substance, even if it destroys their health, that can yield the sought-after end,

the promised land of a dizzy dream. They have enlisted for this end, model airplane glue, lighter fluid, gasoline, nutmeg and ether. Children and teenagers to whom these products are readily available, are among the more prominent users.

The consequences, for adults and youngsters alike, are grave. Liver damage is common. Glue-sniffing produces dizziness, stupor and unconsciousness. Inhaling lighter fluid and gasoline also leads to unconsciousness. Nutmeg produces exhilaration and intoxication accompanied by rapid heartbeat and thirst. But the most serious danger is that the constant user of these makeshift, improvised substances is on his way to becoming a confirmed drug abuser. The next step after sniffing glue is the discovery of even more potent drugs.

Policing problem

Doctors, parents and teachers, even government authorities, recognize the gravity of the problem. Increasingly, the police realize that one of their biggest tasks is coping with drug addition and drug abusers. The number of drug users makes the job of enforcement formidable. The difficulties multiply with the increasing number of new drugs, which though developed for medical purposes, fall into the hands of abusers. To give law enforcement officers a precise picture of the drugs that are abused and the ways of the abuser, the pharmaceutical house of Smith Kline and

Drugs are manufactured in basements, garages, are often impure, unsafe.

French has just published a handbook, some of the points in which are among those made here. For, though most readers of *Inside Psychiatry Today* are not law-enforcement officers, the more they understand about drugs, the less likely will they be to fall into the trap that springs shut on every addict.

Market supplies

Drugs which can be used abusively rarely get on the market through physicians or druggists. In 1963, only 74 out of 300,000 persons arrested for drug traffic were physicians and pharmacists. The culprits are clandestine drug "manufacturers," operating in basements or garages. The drugs they supply are often contaminated, which, of course, is an additional hazard to the user, or rather abuser.

The illegal traffic in narcotics extends around the world. Its principal product is heroin. In the United States, it has no legitimate medical use and may not be legally possessed. For this illegal sale, the sentence is not less than five and not more than twenty years for the first offense and not less than ten and not more than forty for the second. The sentences may not be suspended nor may probation or parole be granted. Yet, severe pun-

ishment under the law hasn't slowed down drug traffic.

Federal control, however, does not extend to amphetamine-like compounds and to barbiturates. Illicit traffic in these drugs is not regulated. Many feel there is an urgent need for federal legislation that would at least require registration of manufacturers and wholesalers.

Psychosis and the Pill

AN INSTANCE of psychosis following withdrawal of Enovid prompted a clinical survey of this and similar compounds by Francis J. Kane, Jr., M.D., assistant professor of psychiatry; Robert J. Daly, M.D. resident in psychiatry, and John A. Ewing, M.D., professor and chairman of Psychiatry, University of North Carolina School of Medicine, Chapel Hill.

Among the 125 subjects of the contraceptive study, four dropped out because of depression. None had such symptoms before, and all returned to normal after stopping the drug. Tension, irritability, easy tearfulness, and mild to moderate depression were principal symptoms, with lethargy as a frequent accompaniment. All reported a change in their usual ability to tolerate stress.

Six other depressed patients were referred by doctors for evaluation. All had become acutely depressed, tense and irritable within the first three months. One suffered complete loss of libido, two had dramatic increases in sexual drive and one had suppression of lactation. One patient reported suicidal ideas.

A number of patients reported increased feelings of well being, without elation, and some reported increased sexual drive and satisfaction. One such patient, using Enovid for control of bleeding, reported relief from her arthritic symptoms. Several patients reported complete loss of sexual interest, one concomitant with thrombophlebitis.

The many clinical reports of decreased premenstrual distress prompted the researchers to use this medication clinically in the treatment of a borderline schizophrenic patient. She received the medication double blind; there was relief of symptoms on active medication and relapse on placebo. Several similar instances were seen in postpartum depressions, with one patient becoming elated.

The investigators concluded: "Careful evaluation, before and during therapy, of individual responses to Enovid and other similar compounds will be necessary to prevent adverse reactions. Our clinical experience, plus that in the literature, suggests further evaluation in the therapy of psychiatric disorders of the premenstrual and postpartum periods."

The study shows that Enovid can not be viewed as an unalloyed blessing in simplifying the birth control problem. Significant individual differences in reaction, such as psychosis and depression, should give pause.

THE ASTRONOMY STORY

American Museum of Natural History

Astronomers have so much new data on the solar system that the old theories are being thrown out much faster than new ones are accepted. There's no longer unity.

by Daniel Cohen

THE DISCUSSION at a recent astronomer's conference on the moon and the planets put one in mind of the tale of the six blind men and the elephant. The first blind man feeling the elephant's trunk thought it was a snake, the second touching the elephant's side said it was a wall, the third grasping the tail thought he had a rope, etc.

Of course, the 200 astronomers who held the six-day conference at Pasadena, Calif., in September, sponsored by California Institute of Technology and the Jet Propulsion Laboratory (JPL) can hardly be thought of as blind men. But the solar system is an enormous elephant and only within recent years have astronomers been able to "see" or "feel" various parts of it. As yet, they are not sure what it all means and, as with the blind men, interpretations differ wildly.

According to Dr. Lee A. DuBridge, president of Caltech, the conference was called to assess the revival of interest in the solar system. Dr. DuBridge said that the 1960's have seen more advances in planetary astronomy than the entire period since the days of Galileo and Kepler. The new findings have left old theories in disarray and the astronomers at Caltech were trying to bring order out of the present chaos.

Here are some of the ideas discussed at the conference:

The Moon. Russian scientist Dr. V. S. Troitskii of the Scientific Research Radio Physics Institute said his observations indicate that the lunar surface is covered with a 20-foot-thick layer of dust-like

material. His radio signals indicate that the moon's temperature increases for about the first 20 feet below the surface and then the temperature levels off. Twenty feet of dust covering the lunar surface could account for such a reading, Dr. Troitskii believes.

Working from another angle, Dr. Donald Gault of the National Aeronautics and Space Administration's Ames Research Center has come up with a similar conclusion. Dr. Gault compared photographs of earth craters formed by explosions or missile impacts with the moon photos taken by the Ranger satellites. He estimated that the depth of loose material would be about 26 feet.

Still a third scientist arrived at the same conclusion from a third angle. Dr. Leonard D. Jaffe of JPL used the Ranger photos to construct model craters. His estimate of the depth of loose material is 16 feet.

Despite the three studies there was no unanimity among the astronomers regarding lunar dust. Present at the conference was Dr. Gerard P. Kuiper, astronomer at the University of Arizona, who doesn't believe the moon has any appreciable dust cover at all. He did not change his opinion. (See "Scientists Argue: What Is the Moon Made Of," Oct. '65).

Another of Dr. Troitskii's conclusions stimulated an almost unanimous reaction—but it was disagreement. Dr. Troitskii told the conference that on the basis of his complex computations he estimated that the moon is four or five times as rich in radioactive materials as the earth, and that it may have a molten core that accounts for one-third of the entire body. The majority of scientists do not think the moon has any molten core at all.

Dr. Troitskii noted that his findings do not rule out the old but largely disbelieved theory that the moon was torn from the earth early in its history and left the gigantic basin now filled by the waters of the Pacific Ocean.

The molten core might also account for the lava flows that some, but not all astronomers, believe form the major features of the moon's surface.

How hot is Venus?

Venus. John Strong, an astrophysicist from Johns Hopkins University, held forth with a minority view that Venus may be cool enough in spots to support life. He said balloon telescopic studies indicate that surface temperatures on Venus vary from 450° F on the sunlit side to 338° F on the side facing away from the sun to a little below zero at the poles. Dr. Strong is unconvinced by the data transmitted by the Mariner II Venus probe which indicated surface temperatures of about 800° F, far too high to support life as we know it.

Dr. Strong also said his telescopic studies indicate the presence of a considerable amount of water vapor in the planet's cloud cover.

Some astronomers challenge "no life on Mars" verdict after Mariner IV

Based on these findings, other scientists described the Venusian clouds as similar to earth's cirrus clouds.

Inevitably, the findings could be accounted for in an entirely different manner. Dr. Lewis D. Kaplan of JPL said Dr. Strong's observations could be due to the presence of carbon dioxide instead of water. And Dr. Hyron Spinrad of the University of California at Berkeley believed there is very little water vapor on Venus—no more than there is on Mars.

Dr. Strong admitted that he was just advancing his ideas to keep Venus interesting to astronomers, and *The Los Angeles Times* quoted one Caltech professor as saying, "If 200 men heard Strong, it is safe to assume 199 did not agree with him."

Mars. Dr. Guido Munch, professor of astronomy at Caltech, compared recently observed characteristics of Mars with those of Venus and found them puzzling. Mariner IV found Mars to have a thin, cold atmosphere, he said, while Mariner II found Venus to have a thick, hot atmosphere. It has been speculated that Mars' lack of a magnetic field allows solar particles to heat up and thus dissipate the planet's gases, he pointed out, yet there is an almost total lack of a magnetic field on Venus, too.

Shortly after the Caltech conference closed, *Science,* the official journal of the American Association for the Advancement of Science, published reports by three different groups challenging the preliminary interpretations of the Mars photographs taken by Mariner IV in mid-July (see "Obituary of a Planet," Oct. '65). That preliminary report, compiled by Caltech and JPL scientists, estimated that the surface of Mars may be scarred by more than 10,000 meteorite craters. "By analogy with the moon," the preliminary report said in August, "Much of the heavily cratered surface of Mars must be very ancient—perhaps two to five billion years old." Since the ancient craters showed little evidence of erosion, the scientists concluded that the planet never had a very dense atmosphere that would shield the surface from meteorites or enough water to form the streams and oceans that produce erosion.

Although the photos, in this view, did not rule out the possibility of life on Mars, they did suggest "that the search for a fossil record appears less promising," since water is necessary for life.

Not so, say the reports in *Science.* They see the surface of Mars being formed much later than two to five billion years ago. And if these craters are new, then the surface may have been subjected to a high degree of erosion in its past history.

Edward Anders of the University of Chicago and James Arnold of the

University of California in San Diego believe that many more crater-forming bodies rain down on Mars than on the moon. Thus, if the Martian surface has been open to bombardment as long as the airless moon, it should have six times as many craters as indicated in the Mariner photos. The two scientists estimate that the craters are only between 300 million and 800 million years old. Other estimates set the craters' age even later. Researchers at the Illinois Institute of Technology Research Institute in Chicago said the Martian craters were at most 300 million years old. In a third report, Ralph Baldwin of Oliver Machinery Co., Grand Rapids, Mich., calculated that the craters were 340 to 680 million years old.

Most startling

Jupiter. The astronomers assembled at Caltech also puzzled over what is probably the most unexpected discovery of all in recent observations of the solar system. This is the possibility that the spin rate of Jupiter, the largest planet in the solar system, speeded up around 1960. Jupiter's spin is extremely rapid in any event, and it is difficult to see how such an enormous mass could have acquired any additional momentum without defying some basic physical laws.

At least one scientist questioned the validity of the "speedup" observations. Since the surface of Jupiter is not visible, its rotation has been

How Fast Can You Read?

A noted publisher in Chicago reports there is a simple technique of rapid reading which should enable you to double your reading speed by this simple, proven method and yet retain much more. Most people do not realize how much they could increase their pleasure, success and income through reading faster, easier, more accurately. The details of this method are described in a new book, "Adventures in Reading Improvement" sent free on request.

According to this publisher, anyone, regardless of his present reading habits and reading speed, can use this simple technique to improve his reading ability and develop it to a remarkable degree. Whether reading stories, textbooks, technical matter, it becomes possible to read sentences at a glance and entire pages in seconds by following this method.

To acquaint the readers of this publication with the easy-to-follow rules for developing rapid reading skill, the company has printed full details of their interesting self-training method in a new book, "Adventures in Reading Improvement" which will be mailed free to anyone who requests it. No obligation.

Simply send your request to: Reading Improvement Program, 835 Diversey Parkway, Dept. C789, Chicago, Illinois 60614. A postcard will do.

New tools, techniques for exploring the night skies promise untidy results.

calculated on the basis of radio "landmarks," that is, bursts of radio energy originating at specific spots within the atmosphere. Most of the scientists accepted the observations as valid. On the basis of the same type of observations, Dr. James W. Warwick of the University of Colorado noted that Jupiter now appears to have returned to its previous rotation rate.

The nature of the surface of Jupiter also came under discussion. Many astronomers speculated that this giant planet does not have any sharp boundary between atmosphere and land, as does the earth. They saw the surrounding gas becoming denser and denser at greater depths and changing from gas to liquid to solid and finally to a molten inner core for the planet. It was a change in the rotation speed of this molten core that caused the 1960 speedup in rotation, Dr. Raymond Hide of the Massachusetts Institute of Technology believed; if the inner core rotation had slowed down in 1960, the rotation of the outer shell would have speeded up a corresponding amount. This would have conserved Jupiter's angular momentum and kept the rotation change within the boundaries of orthodox physical theory.

The problem of the rotation of Jupiter, like all the other problems discussed by astronomers today, is unresolved, and is likely to remain so for some time. Radio observations of the planet have been made only for the past ten years, far too short a time to tell whether a change in the rotation of these "radio landmarks" occurs regularly or not, or even if such "landmarks" are a valid measure of the rotation of the planet.

The tools and techniques astronomers now have at their command are new, and more advanced ones are being added all the time. Traditionally, astronomers have made observations over decades or even centuries before any synthesis could be wrought from them. The information gathered by radio astronomy and other modern methods are a few years old at most.

For the astronomer, the foreseeable future will be an exciting but somewhat untidy period.

"Well, do I have to shout 'eureka' for you?"

TIPS AND TRENDS

BIG JOB OPPORTUNITY. Openings for computer programers far outnumber the supply; 25,000 more are needed. Training programs are beginning around the country. If you're good at puzzles, chess, bridge, you're in.

PILL-TAKERS, NOTE. The rash of new sustained-action drugs has medical and pharmaceutical authorities worried. Reason: The drugs are not always released as they are supposed to be. Most of them get their around-the-clock effect with coats of chemicals or wax that resist digestive juices for varying periods. But sometimes the coatings become altered and a pill-taker gets too much of a drug at one time or not any. Coming soon: a pill, to be made in Europe, that puts you to sleep, then wakes you up after nine hours; eight-hour asprins (already approved by the FDA).

SPACE RESCUE SERVICE NEEDED. The Martin Co. of Baltimore wants to see us be prepared to do something when the first astronaut gets stuck in orbit. Michael Stoiko, technical director of the firm, which makes rockets, says 22 American and Soviet spacemen will be stranded during the next 20 years.

COMING: QUAKE FORECASTS. Within 10 years, earthquake warnings may be as routine as hurricane warnings. A top scientific panel has outlined a 10-year program of research that could cut quake fatalities 80 p.c. And a research center has opened in California.

SCIENCE DOLLARS TO BE SPREAD. Universities that get few or no Federal funds for research will be getting more. President Johnson directed agencies to be more responsive to them--also to give administrators and researchers more discretion in using funds.

BEWARE SMALLPOX. New York, Miami and Los Angeles could have outbreaks imported from abroad, says a U.S. Public Health official.

FAR-OUT DEPARTMENT. Saliva will supplement blood as a medium for diagnosing disease.... Gravityless orbiting hospitals will help cure many ailments....Nuclear charges will tap hitherto unusable gas and oil deposits.

# # # # #

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HUBERT PRYOR, Editor

INVENTOR OF THE MONTH

How to make plants less thirsty

ONE WAY to save water is to keep our trees and crops from "perspiring" so much. *Science Digest's* Inventor of the Month, an engineer named Wyndham J. Roberts, has discovered a chemical method that "substantially inhibits" the transpiration of moisture from plants.

Roberts is on the staff of the Illinois State Water Survey, to which his recent patent, No. 3,205,059, is assigned. He is stationed at the University of Illinois in Urbana.

The method is to apply a higher fatty alcohol in water to the soil. The substance is absorbed by the roots. Eventually, it reduces exhalation from the leaves and other parts of a plant above ground, thus cutting the plant's need for water.

In a campus greenhouse at Urbana, Roberts experimented with potted hybrid corn plants. In a field at Southern Illinois University, Carbondale, he subjected a field of grass to similar treatment. These and other tests, including application to pine seedlings in Wisconsin, gave him gratifying results in the reduction of moisture loss.

As the patent explains, the inventor prefers to use two alcohols derived from beef tallow, in the proportions of about one-third hexadecanol and two-thirds octadecanol. Another possible source of the alcohols is whale blubber.

Wyndham J. Roberts found a chemical to "inhibit" the transpiration of plants.

The U.S. Bureau of Reclamation uses the same two alcohols in experiments with films that reduce evaporation from reservoirs.

As the heat resulting from evaporation is also reduced, it is said that plants may be grown in relatively colder climates.

According to the patent, seeds treated with the alcohols grow into plants with lowered moisture loss. The chemical may be applied during, just before or just after the planting.

Among interested callers at Urbana have been Japanese specialists. In their country, fatty alcohols have been applied to rice paddies. The visitors took home the idea of putting chemicals at plant roots.

—Stacy V. Jones

INVENTIONS PATENTS PROCESSES

Electric cloth to warm you

HEATED seatcovers in 1966 cars are the first commercial use of a new cloth that conducts electricity. The seatcovers are an optional luxury in several models. The cloth is part of the upholstery and is expected to last the life of the upholstery.

Known as Ucar electrically conductive cloth, the new material was developed by Union Carbide Corporation, Carbon Products Division.

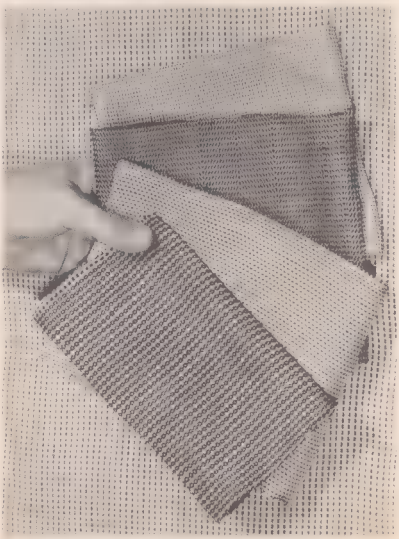
The cloth is woven with carbon and glass yarns. The pattern of the weave determines the heat capacity of the cloth. The glass yarn separates and insulates the carbon yarn.

Woven Ucar looks, handles and drapes like glass drapery fabric. In tests, the cloth has been flexed more than 20,000 cycles without change in its operating power. This suggests that it can be used to heat bedding and clothing. For example, it might be connected to a portable power supply and line ski boots or overcoats.

The shape is not limited; it may vary from a narrow ribbon to a large blanket. It can also be formed into rigid and semi-rigid laminates and reinforcing fibers. For example, it can be added to the leading edge of an aircraft's wing and used to melt ice, a hazard in light planes.

Carbon cloth wields one major advantage over the usual wire heating design. The latter's heating element is generally a single, continuous wire. Failure at any point stops heat everywhere. Carbon yarn conductors are parallel and the loss of a single carbon yarn can hardly be noticed in performance.

Maximum continuous operating temperature recommended for the fabric is from 450-550° F. The volume resistivity of National grade VYB carbon yarn at room temperature is approximately 0.0006 ohm-



Made of carbon and glass, Ucar cloth patterns determine the electrical charge.

Vision doesn't end during rain with S.P.R. as shown on the above left windshield.

centimeters; that is 60 times the resistance of nichrome wire and 3,500 times that of copper. Carbon yarn is clean and has about two-thirds the strength of glass yarn of the same weight.

Electrical connections to Ucar can be made through light clamping pressure, attached metal foils and braided wire tape. Corrosion is impossible, as the yarn is chemically inert.

Rain repellent

A compound that looks like black shoe paste can be rubbed on a car's windshield and cause the next rainstorm to bounce off harmlessly.

Dr. D. F. Stedman of Canada's National Research Council invented the compound, Semi-Permanent Repellent. A patent is pending.

S.P.R. is decomposed by friction. Broken molecules combine chemically with the surface of the glass to become part of it. The coating is only one ten-millionth of an inch thick.

It is most effective on aircraft windshields where the faster speed sweeps the rain away. S.P.R. gives almost perfect vision in weather that makes an untreated windshield "look like a sheet of white paper."

Vision is not obscured, power lines and flagpoles are clear and the horizon shows at the proper level. The heaviest rains look like tiny grains of pepper striking the windshield and are blown away in the slipstream.

Signals in space

Signals suspended in space will flash before pilots to aid in instrument checks with a new "Head Up" unit made by a British firm.

Elliott Brothers of London, England, designed a small computer to monitor information from controls located in various places aboard the craft. Data is projected in symbols

on a transparent reflection glass focused at infinity in the pilot's line of vision. This allows him to continue looking ahead without refocusing his eyes, while checking information on the aircraft's airspeed, altitude and navigation.

The unit can be fitted on any type of aircraft and is said by Elliott Brothers to enhance the safety of automatic landings.

Fast-scan TV

Major changes in the TV industry, particularly for closed-circuit users, may follow a new system of picture transmission, granted patent 3,204,026.

George Doundoulakis, an electronics engineer, invented the Sonic Vee system, whereby fast-scan TV pictures may be transmitted on extremely narrow bandwidths.

In conventional TV scanning, each bit of information before the camera is seen as a black and white dot, a tiny pinpoint that is scanned at the rate of 10,000,000 per second. The dots are transmitted to a receiver, the TV set. Each time, the scanner picks up all the information and transmits it anew. This requires a large bandwidth of four and a half megacycles, limiting the number of broadcasting stations to the few bandwidths that are available. Such broadcasts also require expensive coaxial cables for transmitting the picture.

The Sonic Vee system uses a memory tube that retains the still portions of the picture and holds them on the screen. The velocity scanner transmits only the moving portions. Such a system needs 1/150th of the ordinary TV bandwidths, or only 30,000 cycles, according to Ira Kamen, an electronics engineer associated with Doundoulakis.

The system would allow a picture to be broadcast across nine telephone lines, each providing 3,500 cycles rather than requiring installation of the far more expensive coaxial cables. Doundoulakis estimates the system could reduce closed-circuit line charges by 95 percent.

The system would be valuable for military security systems, pay TV and industrial closed-circuit

Steering on 156-inch diameter booster rockets in the near future will be improved with the hot-gas valve shown during three stages of testing. Lockheed Propulsion Company, Redlands, Calif., subjects the

programs for restricted audiences. In January, Western Union is planning a demonstration of facsimile broadcasting.

Kamen said the Sonic Vee system should bring a breakthrough in home recordings and playback equipment by substantially reducing the recording cost.

Astronaut scoop

Astronauts won't have to dangle on the end of a rope during recovery operations, thanks to a new scoop attachment for helicopter rescue work.

A rigid net and boom can attach to the helicopter's forward section and is offset towards the copter's entrance hatch side so the net can pivot to the hatch for retrieval or storage. The pilot can see the recovery operation.

Presently, helicopter rescue and recovery operations require the helicopter to hover dangerously close to persons or objects below, or to lower a line to them. Usually, a crew member descends the line to secure it to those rescued. Either way, the pilot lacks a clear view of what's happening.

The boom is made of tubular aluminum in a cantilevered truss. The basket is plastic-covered wire net which resists salt water corrosion. The assembly weighs 175 pounds and was developed at NASA's Manned Spacecraft Center in Houston.

valve to 120 seconds of severe rocket exhaust environment. The motor-mounted valve operates repeatedly through preprogrammed duty cycles while exposed to temperatures close to 6,000° F. Photo at left shows full rocket exhaust being directed through bypass nozzle. Center photo shows bypass leg closing and final photo records re-opening of bypass. The Air Force is sponsoring the research.

Life from chemicals

UPI Photo

U. of Illinois' Prof. Sol Speigelman synthesized one type of RNA in the lab.

FOUR biologists have moved science closer to understanding how life first developed and how characteristics of life duplicated.

Although each worked on unrelated research, the new knowledge adds three steps to our understanding of heredity. One biologist began with basic components of the atmosphere, another with fragments of a simple form of life and the others with a new bath for living molecules.

Dr. Cyril Ponnamperuma, chief of the Chemical Evolution Branch of NASA's Ames Research Center in California, joined two links in the molecular chain of life for the first time under laboratory conditions that simulated the atmosphere of the primitive earth.

In a carefully-designed experiment, Ponnamperuma heated uridine, a combination of a base and a sugar with a phosphate salt at 160° C and produced diuridylic acid, the first dinucleotide ever linked under simulated primitive earth conditions.

Nucleotide molecules consist of three parts - a base, a sugar and a phosphate. The base and the sugar are composed of carbon, hydrogen, oxygen and nitrogen, all present eons ago. Nucleotides that contain deoxyribone type sugars are called deoxyribonucleic acid, or DNA. The DNA chains in the nuclei of living cells contain the genetic pattern from which RNA (ribonucleic acid) chains guide the growth of the cell and the production of new cells.

Primitive earth model

"In preparing the nucleotides we went back to the model of the primitive world proposed by the British physicist J. D. Bernal," Ponnamperuma explained. That included an atmosphere of water, ammonia and methane, bombarded by radiation and ultraviolet light.

The biologist pointed out that

the reaction also took place at lower temperatures, at about 50° C. "It is significant," he said, "That the reaction occurs at relatively low temperatures. It is possible that inorganic or organic catalysts present in the primordial environment may have promoted this reaction and perhaps have given rise to longer chains of nucleotides," he told a meeting of the American Chemical Society.

Synthesis

Dr. Sol Spiegelmen of the University of Illinois synthesized a self-duplicating, infectious RNA.

He mixed precise quantities of a pure enyzme, four triphosphates and RNA virus genes, ended their reaction with an ice bath and then filtered and washed the substance seven times.

The material was allowed to grow in a test tube, then a few molecules of RNA were transferred to another test tube and so on until the original material was so diluted that less than one molecule of the original mixture was present. Yet, the viral RNA molecules grew in all the test tubes.

The step of making active RNA outside of a living cell foreruns a time when the code-carrying DNA is synthesized, Speigelman believes. "For the first time, a system has been made available which permits the unambiguous analysis of the molecular basis underlying the replication of a self-propagating nucleic acid," he said.

Drs. James Bonner and Ru-chih Huang at the California Institute of Technology used a non-acid treatment to discover an unsuspected type of RNA that attaches to DNA genes.

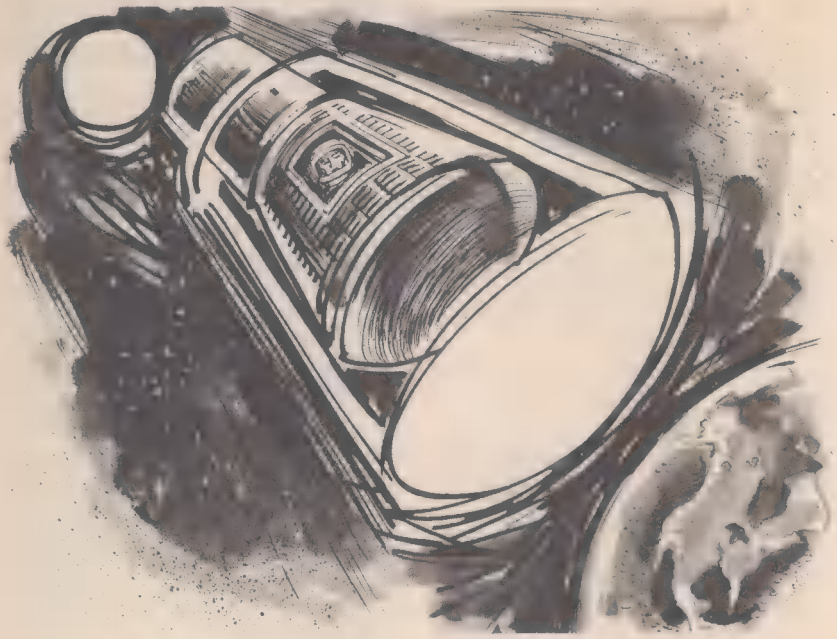
The newly-discovered RNA may play an important controlling role in directing heredity.

Previously the two scientists showed that materials called histones were present in cells containing the code-carrying DNA. They found the histones were able to shut off DNA genes. A DNA gene was only active if it were free of histones. While all the DNA cells carry a complete set of instructions for becoming or reproducing a heart cell, a blood cell or a nerve tissue, a cell develops into the proper tissue because histones "sit on" the extraneous instructions.

New kind of RNA

Bonner and Huang believe their new discovery may signal a new kind of RNA which only is attached to histones. Perhaps this histone-RNA directs the histone to "sit on" portions of the DNA. They are now continuing their experiments to see if a deeper understanding of the role of this substance can be obtained.

Histone-RNA was overlooked earlier because all experimental methods to isolate histones included an acid. Acids detach and separate the histone-RNA from the histone so it never appeared in experimental results.



How to fall up

If science can find a material that will block the earth's gravity, then a space traveller will be exposed only to the pull of the moon above.

by Bruce H. Frisch

Astronaut Thurston Jutjaw broke stride at the launching pad to flash a smile toward the TV cameras. His eyes lowered to the spacecraft. What an ugly thing. Pivoted to the top were what looked like the two jaws of a clamshell steam-shovel bucket.

The inside was spacious, as if there had been no attention to weight-saving at all.

At minus 20 seconds Jutjaw glanced through the porthole. That TV guy was staring in at him. The fool. Didn't he know the rocket blast would fry him to a crisp? "6 . . . 5 . . . 4," the launch director's voice droned. "3 . . . 2 . . . 1 . . . FIRE." Jutjaw braced for the roar and the terrific acceleration.

They didn't come. All he heard was ■ creaking as the clamshell jaws swung shut under the spacecraft. He suddenly felt weightless. "What is this?" he thought. He knew he should have read the manual first.

A minute went by. Through the porthole Jutjaw caught a glimpse of the TV guy ducking beneath the cabin. "Jutjaw is a little over two inches off the ground now, folks. Right on schedule," he reported. An hour later he told viewers, "The spacecraft is now about 660 feet over the Cape and gathering speed. It's going about ■ quarter mile per hour."

Inside, Jutjaw had found a copy of the manual. He opened it and read: "The clamshell on the outside of your cabin is a gravity shield. When it closes, it will block out the gravitational pull of the earth beneath and expose you only to the pull of the moon and sun above." He was falling up.

The inspiration for the above fantasy is a prediction by Clyde Murtaugh, an engineer and planner for the Bendix Systems Division of the Bendix Corporation. Earlier in the year he told engineers meeting in Detroit that the conventional rocket, which throws stuff out the back to move forward, is dead.

Today the cost of putting ■ payload in low earth orbit with a "Saturn 1B" is $1000 per pound, he said. By 1972 we may have the proposed "Sea Dragon" which would weigh 100 million pounds and be launched from the ocean. The freight-rate for it would be $200 per pound. What we need, said Murtaugh, is a rate of $10 per pound or we'll have to trim our space ambitions drastically to stay within any conceivable budget.

Around 1971 this need will be pressing enough and the payoff tempting enough to force a breakthrough, Murtaugh predicted. He would expect the new engine to rely on pure gravitational, electrical or magnetic forces, with thrust supplied from the ground.

Murtaugh leaned toward the latter two forces; scientists have speculated most about the first, probably because we don't know enough about gravity to cramp the imagination.

We have shields against electrical forces and shields against magnetic forces. Why not shields against gravitational forces, they have pondered. Years ago H. G. Wells sent a fictional character of his, Mr. Cavor, to the moon in a gravity shield. Mr. Cavor's ship was made of a material, called cavorite, he had invented himself. No real-life scientist has been able to duplicate his achievement.

Materials for shielding electrical forces contain free-moving electrons. The electrical field pushes the electrons to one side of the shield. The separation of charges creates a new electrical field which matches and cancels the original field.

Anti-gravity ignores Einstein, say some; not so, say others

The strength of an electrical field is proportional to charge. A gravitational field is proportional to mass. By analogy, a gravity shield would seem to need a mixture of materials with positive (ordinary) and negative mass.

There may be one minor difficulty. According to the analysis of Peter Bergman of the physics department at Syracuse University, like kinds of mass would attract and unlike kinds of mass would repel. But "repel" in this strange case means that the particles of negative mass would chase fleeing particles of positive mass. Before any shielding effect could be felt, the two kinds of mass would have to be separated some other way, electrically perhaps. In any case, says Bergman, if matter with negative mass exerts as weak a gravitational force as familiar matter with positive mass, its shielding value will be negligible.

Brushing aside this objection, where would we get material with negative mass? Antimatter is a favorite candidate. It has not yet been proved which kind of gravitational mass antimatter has, so scientists are free to speculate. And after all, antiparticles have opposite electrical charge from their corresponding particles, and have the opposites of a lot of other properties. Why not opposite mass?

The astronomers Philip Morrison of Cornell and Thomas Gold of Harvard have suggested that a negative mass for antimatter would explain why we see so little of it. Theoretically there should be as much antimatter as matter. A particle and an antiparticle are created from energy in a pair. If they had opposite kinds of mass and repelled each other, they would separate, and be attracted to their own kind in galaxies kept apart by repulsion (see "Is There a Second Universe?", Sept. '65).

Price too high

Three Soviet scientists, Y. A. Aleksandrov, V. N. Andreev and I. I. Bondarenko argue that the price for such speculation is too high. Evidence so far indicates that antimatter has positive inertial mass, which is measured by its resistance to a push. If the gravitational mass were not also positive, a host of physical laws, including Einstein's General Theory of Relativity, would have to be discarded.

Some scientists, in fact, are quite willing to trade in the General Theory. Only a few physical checks on it have been possible, points out R. H. Dicke of Princeton. Scientists accept it because it has passed these tests splendidly and is so elegantly simple. Nature, says Dicke, may love elegance less than man does.

Within the bounds of the General Theory a second kind of shield may

be possible. It would work like a plate shielding radio waves. A plate shielding waves coming from the right produces waves going to the left which are out of step with the original radio waves and cancel them. "If gravitational forces could be explained in terms of waves," theorizes W. F. G. Swann, director emeritus of the Bartol Research Foundation of the Franklin Institute, and if, when they acted "upon suitable matter, set up other gravitational waves, we might be able to realize a shield for gravitation."

P. A. M. Dirac, the British Nobel Prize-winning physicist, has been able to manipulate the equations of the General Theory to show that gravity waves of useful strength may exist. An instrument to detect them has been built by Professor J. Weber at the University of Maryland. A 1½-ton aluminum cylinder is enclosed in a vacuum to protect it from sound, and is set on special mounts to isolate it from earth tremors. The idea is that interstellar gravity waves will set it vibrating. So far, nothing has been found above the detector's threshold of sensitivity. Nevertheless, one of the experimenters, Robert Forward, now with Hughes Research Laboratories, is building a "cheap carbon copy" in California.

If you accept the General Theory, such a search is hopeless, insists Leopold Infeld, who worked with Einstein at Princeton and is now in Poland. Different materials are equally accelerated by gravity, as Galileo proved. Einstein reasoned that if gravitation did not depend on the materials, it was a property of the space they were in. The upshot was his picture of curved space-time. In pre-Einstein terms, a ray of starlight passing close to the sun is bent by the strong gravitational field. Einstein would say that it is merely passing through a four-dimensional ripple. Thus, if gravity is simply the geometry of space, claims Infeld, there is nothing we can control.

A long way ahead

Forward argues that several anti-gravity machines based on the General Theory are theoretically possible. Imagine this: A pipe as wide as a football field is wound around a doughnut with dimensions in miles. Through the pipe flows matter with the density of a dwarf star (in the neighborhood of a billion pounds per quart). For a few thousandths of a second the flow is accelerated to near the speed of light, then slowed to a stop. The payoff would be a force up through the center of the doughnut that would just balance the earth's pull.

No wonder Forward says, "Practical anti-gravity will unfortunately be technologically impossible for centuries."

He believes in a non-mass-ejecting rocket, though. We'll need it for interstellar travel, he thinks. To get anywhere over such distances we will have to reach almost the speed of light. The amount of energy required would be beyond a conven-

tional rocket. In his files Forward has collected scores of schemes for electric or magnetic power.

A spaceship on the moon might charge up the moon so that it repelled the ship into space. Or a ship might be coated with a radioactive paint. Decaying atoms would eject positively charged alpha particles. Either way the ship would be left with an opposite charge. The interaction of the charge moving through the magnetic fields that exist in some regions of space would produce a force that could be used to change course.

Actual progress slow

Back in the reality of today's technology, electrical and magnetic levitation are coming along slowly. Rotating parts of small instruments like gyros have been supported. With new superconducting materials, applications to larger machines are possible. One project aims at supporting a railroad car. In all cases the apogee of the "launch" is a fraction of an inch.

Over the next 20 years a system working against the earth's magnetic field to create guidance forces is the most that can be seen by Dandridge Cole, big-picture man for G.E.'s Missile and Space Division (see "Dandridge Cole: G.E.'s Way-out Man," July '65). He claims that a string of refueling stations that makes the fuel on the spot will cut costs, and the costs for the big boosters won't be nearly as high as Murtaugh estimates, Cole says, quoting several well-known studies.

Manufacturing fuel on the moon is "a long way from reality," Murtaugh answers. "Someone will come up with something new and novel first." The studies he writes off as salesmanship for bigger boosters. "The sledgehammer approach won't work beyond Saturn," he says, but admits he couldn't convince his own company.

The subject is still above the wild speculation level. Evidence of the Air Force's concern came a few years back when talk about antigravity shook it into commissioning a study. Dr. Kirill Stangukovich, a Somebody in the Soviet space program, began mentioning a forthcoming "graviplane." He had a theory that matter radiated gravity particles (The future discovery of a graviton particle in a giant atomsmasher is considered a possibility.) by vibrating billions of times a second. Cool matter to absolute zero to still the vibrations and it would become weightless.

The study found that other Soviet scientists gave him no support and even scorn. Those who are looking for anti-gravity suffer "uncertainty and frustration," the report concluded, but "their efforts are so intense and unflagging that they warrant the closest continued watchfulness."

Here, the Air Force, other government agencies and industry continue to give gravity research moderate support. The money is a $2 bet on a long-shot to hedge the billions put on the favorite.

Harold L. Fitch, seen topsy-turvy in the mirror, checks one of 950 locations on a model Apollo spacecraft. Study is part of a project that will help predict space heat loads.

Which side is up?

SCIENTISTS at Midwest Research Institute are using a concave mirror or parabolic reflector (above) to help solve one of the complex problems involved in getting man to the moon by 1970. The reflector turns an image upside down, simulates lighting conditions in space. The researchers are gathering data on the shadow patterns cast on a scale model of the Apollo spacecraft.

Temperatures in the lighted and shadowed areas could range from 500° F. to 200° F below zero. Naturally such extremes would have a bad effect on the operation of flight controls and instruments, and on the safety of the astronauts making the trip.

The data, which is being obtained for every possible attitude and position relative to the sun, permits the researchers to predict more accurately the heat loads that must be compensated for with an advanced thermal control system.

There are numerous means of thermal control; they include venetian-type blinds to shade areas, heaters to warm sensitive controls, and coatings that selectively reflect and absorb heat.

The reflector, which originally was part of a searchlight, illuminates a one-tenth scale model of the Apollo. Shadow patterns occur in areas where there are protrusions, such as landing legs, antennas, and nozzles. There is intense shadow on the spacecraft's "dark" side.

Drastically new curriculum faces this year's freshmen as they register at the "big daddy"

Great Dome, an M.I.T. landmark, is dated 1916, the year "Boston Tech", as the school was called, moved to Cambridge.

Revolution

In his last annual report, President Julius A. Stratton of M.I.T. noted a "profound" difference between today's freshmen and those of 10-20 years ago.

He saw modern undergraduates "caught up in a bitterly competitive system—a kind of competition for higher education that is rather new to Americans. . . .

"At the root of the matter is the tremendous increase in technical knowledge which must be mastered if one is to enter successfully into any of the modern professions."

To help that mastery, M.I.T. undertook "the most extensive review of our undergraduate program" in the school's history. Result:

This year's freshmen have been introduced to a curriculum revolution, "drastic changes" in the cur-

of American science schools, the 100-year-old Massachusetts Institute of Technology.

at M.I.T.

riculum, as an M.I.T. announcement calls them. Hitherto, all students have been required to take the same core courses in physics and mathematics during the first two years, with at least one humanities course every term through four years. And all but architecture students were required to take chemistry through the first year. Now core requirements are one year of physics, one of math, one semester of chemistry.

The new program seeks to allow for differences among freshmen, in their interests and their preparation. They'll spend 45 to 51 hours a week in class, lab and study, as before, but they'll have more choice in studies, including the humanities and advanced courses. M.I.T., though, emphasizes it's still "a university polarized around science."

School's 7,324 students (50 p.c. undergrads) include M. L. Rodburg, Union, N.J., left, Stephen Kanter, Cincinnati.

Freshmen work in a physics lab. Science and engineering studies predominate at M.I.T., but school is also devoted to social sciences and humanities that relate to technology.

OF 964 freshmen who registered at M.I.T. this fall, 10 percent were from Massachusetts and the rest from 48 other states and 54 foreign countries.

At least 776 were in the top tenth of their high school classes, 56 were in the second tenth and 20 in the third tenth.

It used to be said of M.I.T., President Stratton has recalled, that it was a place "easy to enter but hard to stay." Today, he pointed out, "the reverse proves to be true." In 1964, less than 3 p.c. of the freshmen withdrew for academic reasons.

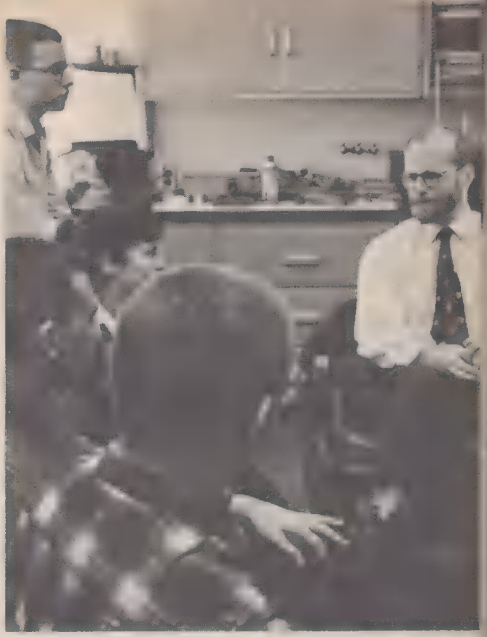
With a greater choice of courses, plus a plan to "give freshmen more help," this year's figure may be even smaller.

What will the students study?

M.I.T. offers bachelor's degrees in 25 "courses" (the name given to organized undergraduate curricula) in architecture, seven fields of engineering, three fields of the humanities and social sciences, management, and five fields of science. The 25 courses are:

Aeronautics and Astronautics, Architecture, Biology, Chemical Engineering, Chemistry, City and Regional Planning, Civil Engineering, Economics, Electrical Engineering, Geology and Geophysics, Humanities and Engineering or Science, Industrial Management, Linguistics, Mathematics, Mechanical Engineering, Metallurgy and Materials Science, Meteorology, Naval Architecture and Marine Engineering, Nuclear Engineering, Nutrition and Food Science, Oceanography, Philosophy, Physics, Political Science, and Psychology. (To be noted: the big increase in social sciences).

Student's work is checked by Prof. Harold E. Edgerton, who developed strobe.

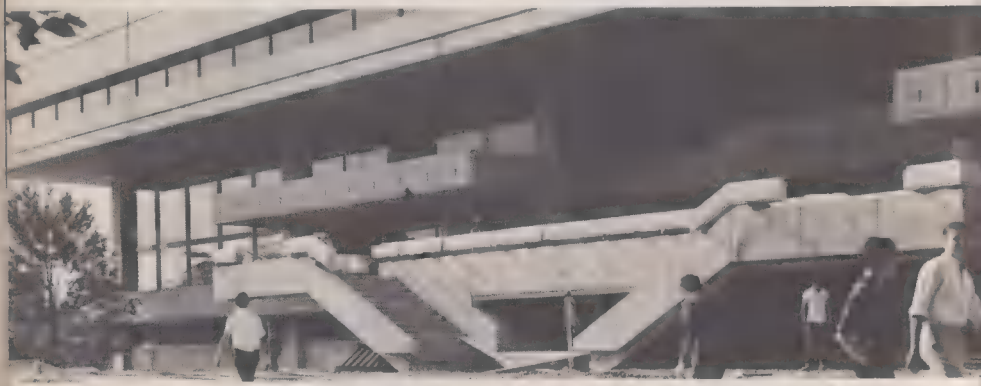


Prof. Patrick D. Wall, at seminar here, is known for his work in neurophysiology.

Four years of competitive work lie ahead for two of 49 women among 1965 freshmen—Maria Kivisild, Willowdale, Ont., Canada, left, and Judy Coletti, Newton, Massachusetts.

President Stratton was in class of '23; 90 p.c. were engineers, now 50 p.c. are.

Faculty of over 1,400 includes Charles Hard Townes, who invented maser, laser.



Above: New student center building designed by Prof. Eduardo Catalano, an Argentine architect, has two great halls, a grill room open to 2 a.m. and many recreation facilities. Below: Downtown Boston looms across Charles River. Left is the Earth Sciences tower.

In room adjoining synchrotron of Laboratory for Nuclear Science, big ideas grow across cluttered table. Talking: Prof. David H. Frisch. Listening: Asst. Prof. Alan J. Lazarus.

At M.I.T., it's hard to keep in mind that its prime function is education.

The pressures and achievements of research at the Institute are many. As recently as October 1, the school dedicated a $6 million building for the interdepartmental Center for Materials Science and Engineering. The building is the largest M.I.T. has built in 50 years. Helping support and administer it is the Defense Department's Advanced Research Projects Agency.

Other private and government research activities surround M.I.T.

The research horizons at the Institute, besides those mentioned, can awe one: plasma physics, ion propulsion, magnetohydrodynamics, viral biology, biophysics, aerospace, radio astronomy.

So you want to go to college and have fun? There is that, too, at M.I.T., if any students are interested (most are) and have the time (few have).

While the usual rah-rah spirit is voiced in a low key, one also notes at M.I.T. that the dull "tech" look is getting a little color.

In a $50 million building program now under way, the emphasis is on soft hues on the walls, indirect lighting in the ceilings.

One also senses a new tone in the educational program. President Stratton reiterates the theme that, even though a student plans a career that's not in the sciences or engineering, he's all the better off for having studied at a technological university. A recent M.I.T. bulletin said:

"M.I.T.'s growing breadth is an essential response to the deepening influence of modern technology on every domain of contemporary human affairs; in a very real sense the Institute is a literal expression of the unity of present-day society."

Much has been written about M.I.T.'s very great contributions to the vast technological and scientific advances of recent years. But it is the intangible that occupies President Stratton:

". . . The principal intangible that really distinguishes M.I.T. . . . is a sense of commitment. . . . It is the very epitome of 'learning by doing'; contact with reality, even in education; real-time service, even in school; and objectively facing and entering hard problems with an open mind and a fully marshalled set of resources—as quantitatively as is humanly possible."

If M.I.T. has its way, the world's ills may yet be fixed.

This is the third in a series on America's top science schools.

Idyllic Charles River lends itself to sailing in these tubby so-called "Tech" dinghies.

Huge, glassed-in Alumni Pool is a notable athletic landmark on the 120-acre campus.

Big recreational event of the year is Field Day. Freshmen and sophomores square off in a series of muddy, en masse athletics like this contest to snare rival team's gloves.

Assembly Ball, held each spring, is formal affair arranged by the student staff.

Interfraternity Conference Dance, held last spring, was 100 percent unscientific.

How to cope with cold weather

Shivering and shaking precede an adaptation to chilly climes. Still, Indians and others shrug off icy sleet with ease. How do they manage?

by Andrew Hamilton

As COLDER weather approaches, you may have laid in a supply of coal or fuel oil for bitterly cold weather ahead. You may have had the heater of your car overhauled in anticipation of heavy use. Perhaps you have recently purchased a new overcoat or a thick wool muffler.

But what about primitive man—how did he stay warm? And what about wild birds, mammals and fish—how do they manage to function in bitterly cold environments? If all civilized heating devices were suddenly taken away, could we survive?

One of the world's authorities on coping with cold is Dr. Per Scholander, director of the Physiological Research Laboratory at the University of California, San Diego. His studies have taken him from the deserts of Australia to the mountains of Norway.

Many animals and birds, Dr. Scholander points out, have obvious ways of coping with low temperatures. Dogs curl up more and more tightly into a ball as the temperature goes down. They also raise their hair to trap additional air, and thus insulate themselves against

American Museum of Natural History

Huskies, sled dogs of the Arctic, are content sleeping in the snow in -30 to -40° F weather. Their legs, almost uninsulated, may stay only a few degrees above freezing.

the dropping temperatures.

The Husky, sled dog of the Arctic, has such a heavy coat of fur that it can lie down in the snow and sleep contentedly at temperatures as low as —30 or —40° F.

In land animals, the outer insulation of fur or feathers contributes practically all the insulation. But aquatic animals, such as seals and whales, often have considerable interior insulation in the form of fat. A thick layer of fatty tissue forms just under the skin, conserving the vital interior heat. In some whales, this insulating layer may be four or five inches thick.

Another means of saving interior heat is permitting the extremities to become colder so heat can be concentrated in other areas of the body. For example, some birds are able to sleep while standing on ice. Dogs have less insulation on their legs, and skin temperatures on those parts which are relatively bare is surprisingly low. Measurements deep inside the legs of Arctic dogs and reindeer have shown temperatures only a few degrees above freezing while body temperatures were 50 to 65 degrees higher.

Similar means of preserving interior heat are found in sea mammals. Their problem is that water is some 50 times more heat-conducting than air. "Bio-engineering" research on whales indicates that each artery that enters exposed areas of the tail or fins is surrounded by a network of veins. As the warm blood of the arteries goes into the fins, it comes in close contact with the ice cold blood returning to the heart. As the two streams pass one another, heat from the arteries warms the returning blood —thus preserving some of the interior heat and preventing it from being dissipated in the fins. Although the fins are supplied with freshly-oxygenated blood, they remain relatively cold.

"Particularly interesting conditions have been found in fishes living in Arctic waters," said Dr. Scholander. "The blood of ordinary fishes has a freezing point nearly the same as that of human blood, or about 31.2° F. But when

Surface fish in the Arctic Ocean produce their own anti-freeze

the Arctic Ocean freezes over in the winter, the water temperature drops to 30.2° F., a full degree lower. It would seem reasonable to expect the fish to freeze solid at this temperature, but they do not. Surface fishes produce an anti-freeze in their blood for the winter, but deep sea fishes remain super-cooled."

Dr. Scholander has devoted extensive research to the problem of human adaptibility to cold. Aborigines in various parts of the world have survived cold climates with little or no clothing. Could this ability be developed in civilized man?

Flurry of sleet

More than 150 years ago Charles Darwin visited Tierra del Fuego at the southern tip of South America and found Indians there living virtually naked. As his ship, the famous *Beagle,* landed in a flurry of mid-winter sleet, Indians came out in canoes, apparently indifferent to the ice falling on their naked bodies.

These Yahgan Indians were primarily fishermen, and their boats were moored offshore in kelp beds —necessitating a chilly swim to shore. They built straw huts for shelter and sometimes carried an otter skin for protection, but otherwise they depended only on small bonfires to see them through the winter. The women of the tribe carried their babies on their backs, and one early observer reported that when the mothers plunged into the ocean to swim ashore, the little ones climbed on their heads, trying to keep their feet out of the icy water.

Custom persisted

A similar situation existed among the Australian aborigines who lived without clothing in even the coldest parts of that continent. This custom persisted until only a few decades ago, but even today on hunting expeditions the natives may discard their clothes entirely —or use them as a pillow at night.

Temperatures in mid-Australia often fall below freezing during winter nights, and the natives keep reasonably warm by sleeping on the ground between small campfires.

In 1957, Dr. Scholander and a scientific party went to central Australia to study the natives' ability to live with cold. Using themselves as controls, the scientists compared their ability with that of the natives to sleep nude under such conditions.

"The natives rested and slept through the frosty night with only occasional attention to the fires," said Dr. Scholander. "On windless nights, the scientists could also endure these conditions by constantly

attending the fires. However, they got little sleep—and on windy nights the situation was unbearable."

To obtain scientific measurements of bodily response, thermocouples were placed on various skin locations. These devices showed that skin temperatures of the natives were considerably lower than those of the scientists. At times, parts of the skin shielded from bonfire heat, got as low as 54° F. Yet the natives did not wake up.

It was then decided to test the natives in another way. They were asked to spend the night on a cot in a light-weight sleeping bag that was the equivalent of a single blanket with a wind cover. No fires this time. The subjects were naked inside the sleeping bags and night-time temperatures were near-freezing.

Again the natives slept comfortably. The scientists, however, found their shivering and restlessness kept them awake most of the night. Skin temperatures on the scientists' feet dropped to 59°. The natives' feet grew even colder, but they slept peacefully—snoring rather than shivering.

In common with animals, human beings often react to cold by shivering. This is a process of repeated involuntary muscular contraction that produces heat. Sometimes these contractions are so violent they shake the whole body; other times they are so mild they can hardly be seen.

Among Australian natives, there was little or no shivering. Nor did they increase their metabolic or heat-production rate during the night. Instead, they displayed a striking tolerance of low temperature in the extremities without enough discomfort to keep them awake. In this way, their response resembled that of the Arctic husky, which avoids increasing its heat production by tolerating low temperatures in the legs.

"The response of civilized man is somewhat different," said Dr. Scholander, "though he, too, can adapt himself to some degree of cold."

Hubbard expedition

A striking example of this adaptation was furnished in 1903 by the ill-fated Hubbard expedition into Labrador. Hubbard died on that trip but his two companions walked for two months in deep snow and finally made their way to safety. They lost their shoes and most of their warm garments, and had only a half a blanket apiece at night. Upon returning to civilization they found houses so warm they felt stifled and had to go outside occasionally "to breathe".

Dr. Scholander points out that anyone who goes on a camping trip in the high mountains or other cold territory may find it takes a few nights to become accustomed to low temperatures.

To measure this kind of adaptation, he conducted an experiment in 1956 with Norwegian college

students. In the fall of that year, eight of these young men went into the mountains of Norway for six weeks. They wore light-weight summer clothing—cotton shirts and shorts, socks, and shoes. In cold weather they added a light parka and cotton trousers. During the day, the men sometimes took a dip in an icy mountain lake. At night they slept naked in one-blanket sleeping bags similar to those in the Australian experiment.

For the first four or five nights, the students found sleeping very difficult. They spent most of the time thrashing around to keep warm. But after a week or so they began to sleep very comfortably. They sometimes shivered in their sleep, but did not awaken.

At the end of the experiment, the students were measured during sleep with themocouples placed on their skin, then compared with a group of men who had not been exposed to low temperatures. The difference was striking—but in a way quite different from that of the Australia experiment. The Norwegian student group found comfort through increased metabolism or heat production. Unlike the Australian aborigines, their feet stayed warm, while the feet of those who had not adapted grew painfully chilly.

"Civilized man has lost his natural cold adaptation," Dr. Scholander says, "because he has shielded his body by clothing and shelter too long. But only a few weeks exposure to the cold will produce an adaptation that may be useful to anyone who must live and work at low temperatures."

Science has demonstrated that man can cope with cold.

"I understand the government is getting a nice piece of change for it."

Wide World

The Tacoma Bridge splintered into Puget Sound only 130 days after it opened in November, 1940. A moderate wind of 40-42 mph set the collapse in motion.

The fall of 'Galloping Gertie'

by Robert Kraske

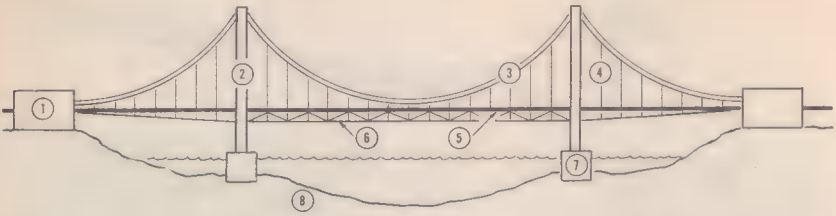
TWENTY-FIVE years ago on Nov. 7, 1940, the brand-new Tacoma Narrows Bridge collapsed with a scream of ripping steel into the waters of Puget Sound.

The bridge, world's third longest in 1940, was all-steel, the product of experienced engineering and skilled construction. It had cost $6.4 million, a considerable sum for those post-Depression days. And yet, from the day of its opening, it stood exactly 130 days.

Engineers viewing the wreckage found the sight hard to believe. The proud bridge had been blown apart in a few hours. Hurricane? Hardly. A mere 40 m.p.h. gale had produced the twisted wreckage.

What flaw in the design was responsible?

To answer the question, bridge authorities convened a panel of expert engineers. As a result of their study, engineers today design windproof suspension bridges—like the 3,800-foot Mackinac Bridge spanning the windy straits between Michigan's two peninsulas and the Verrazano-Narrows across the entrance to New York Harbor, at 4,260 feet the world's longest bridge.



A diagram locates: 1. Cable anchorage 2. Tower 3. Cable 4. Suspender rope 5. Roadway 6. Truss stiffening roadway 7. Tower pier 8. Bedrock or river bottom

Because of their windproof design, these giant bridges can stand against a hurricane and show no noticeable strain.

What happened to the Tacoma Narrows? Where was the flaw in the design?

Soon after the Tacoma Narrows opened on July 1, 1940, the public gave it an unusual nickname: "Galloping Gertie."

"Like driving over a roller coaster," motorists reported. The ride along the bridge made their stomachs feel queasy, from the heaving motion of their cars lifting and falling on waves that ran the length of the roadway.

On days when a fresh breeze blew across Puget Sound, the waves in the roadway reached five feet. A driver might see a car ahead lift on the crest of a wave and then disappear in the trough that followed.

"Galloping Gertie" soon became a tourist attraction. From all over Washington state curious people came to the bridge for the novel thrill of driving along its rolling roadway.

The behavior of the new bridge was strange. But no one worried about it. A bank advertised itself with a sign that read: "As safe as the Tacoma Bridge." Engineers from the University of Washington examined "Gertie." Their verdict: flexible—but sound.

Then, on Thursday, November 7, the bridge faced its first storm.

By 7 o'clock that morning, winds of 42-44 m.p.h. were whipping whitecaps on Puget Sound. The roadway, pushed by the steady pressure of wind, began rocking in the suspender ropes that connected to the high cables.

Closed to traffic

Alarmed, bridge officials ordered the bridge closed.

By 10 o'clock, the motion of the roadway became violent. Waves 30 feet high rippled down its length. At the same time, the entire 2,800-foot span began wrenching in opposite directions. Steel girders twisted like taffy.

Sidewalks bordering the two-lane roadway rose and fell through 28-foot arcs. Suspender ropes slackened and then took terrific jolts

as the roadway dropped. Chunks of curb broke loose. Steel lampposts flopped on their bases like broken reeds.

Engineers raced to the site. But they could do nothing. The bridge, they realized to their horror, had begun a death dance.

At 10:30, a floor panel blew away on the wind.

A half-hour later, before the engineers' astonished eyes, 600 feet of roadway zippered away from the suspender ropes.

Ten more minutes of heaving and twisting, then the rest of the roadway collapsed in a roar of ripping steel and flailing suspender ropes into the cold waters of Puget Sound 208 feet below. Only the towers and cables remained in place, quivering and groaning as they readjusted to the sudden weight loss.

The Tacoma Bridge, proud engineering achievement, had literally been blown apart by the wind!

Over the next five months, engineers appointed by bridge authorities investigated the disaster. Their findings were eventually published between 1950 and 1954. "Aerodynamic Stability of Suspension Bridges" was a classic of its kind. It was the first scientific appraisal of how a bridge could be destroyed by wind.

Designers of the Tacoma Bridge found small comfort in one fact unearthed by the investigators: "Gertie" was the fourth major suspension bridge in the United States to be destroyed or severely damaged by wind in the past 86 years.

In their report, the expert engineers examined the effect of wind on other suspension bridges, including the mighty Golden Gate. In a storm on Feb. 11, 1941, when the wind reached 62 m.p.h., waves two feet high were seen to ripple along its roadway. Even the world's longest suspension bridge in 1941, they observed, was not immune to wind pressure.

As for the Tacoma Bridge, their investigation showed that several factors and conditions had contributed to its fall. Here are their basic findings.

Popular design

The design of bridges, like cars or clothes, runs in trends—popular and accepted ways of doing things.

In the 1930s, when the Tacoma Bridge was on the drawing boards, the trend in suspension bridge design was towards graceful spans: slender towers, sweeping cables, narrow roadways. The suspension bridge had a natural beauty inherent in its structure. Bridge designers were eager to find new ways to exploit it.

The Tacoma Bridge advanced this trend further than any other bridge, especially in the roadway.

The roadway, narrow to begin with because it carried only two traffic lanes bordered by sidewalks, was 39 feet wide—or one foot of width for every 72 of length.

The depth of the girders supporting the roadway was eight feet—or

Engineers laid the blame on an economy girder and the slim style.

one foot of depth for every 350 feet of length.

Other bridges opened in the 1930s—like the George Washington across the Hudson River and San Francisco's Golden Gate—came nowhere close to achieving this slender profile. On the Golden Gate, for example, ratios of roadway depth and width to roadway length were 1 to 164 and 1 to 47.

For the Tacoma Bridge, these high ratios of width and depth to roadway length made for flexibility—like a strip of wood that, because of its proportions, can be bent and twisted compared to a board that resists the same pressures. So, unknown to engineers, they had designed a basic flaw into the Tacoma's roadway.

But the design feature that contributed most to the Tacoma's collapse was, the expert engineers agreed, the girders under the roadway.

Unlike the open-truss girder on earlier suspension bridges, the Tacoma Bridge used a plate girder—an unbroken sheet of steel nearly eight feet high fastened top and bottom to light girders. The plate girder was as strong as the truss girder. It was frequently used on short-span highway and railroad bridges.

For a long-span suspension bridge, its advantage was in cost; it was less expensive to build than the truss girder. The Tacoma was designed during the Great Depression. Cost was an important factor in the design.

But the plate girder, again unknown to engineers, had serious disadvantages for a suspension bridge that, by design and function, had a long middle span. Its flat sides caught the full force of any blowing wind like a billboard.

Open construction

Truss girders, in contrast, have an 'open' construction—short beams between two heavy girders—which allow the wind to blow through rather than against them.

With these findings in mind, the expert engineers reconstructed the tragedy of the Tacoma Bridge. The wind, racing unhindered along Puget Sound, blew under the roadway and into the 'pocket' where the flat plate girders joined the roadway paved with 5¼ inches of concrete.

Blowing at a steady 40-42 m.p.h. against the thousands of square feet of steel and concrete forming the pocket, the wind started the roadway rocking in its suspender ropes. Once started, the roadway's motion fed on itself—built higher and higher under the momentum of its swings.

The plate girder was the real villain of the Tacoma Bridge disaster. When the girder was joined

to a narrow, flexible roadway, the bridge was in mortal danger as soon as a steady wind pushed hard enough to put the whole structure into motion. The Tacoma Bridge, the expert engineers concluded, lacked "aerodynamic stability"—the ability to remain stable in a high wind.

Beneficiaries of the Tacoma Bridge disaster are the engineers who design today's giant suspension bridges.

The late Dr. David B. Steinman, the designer of the Mackinac Bridge, built "aerodynamic stability" into his bridge. With "Mighty Mac," he avoided using a roadway paved solid along its length. Instead, he used an "open grid" roadway on two of the four traffic lanes —steel bars laid at right angles to each other in a grid pattern. The grid causes tires to 'hum' as they pass over. The openings in the grid allow the wind to blow through rather than against the roadway. Even the truss girders supporting the roadway are 'holed' to allow easy passage of the wind.

Dr. Steinman estimated that his bridge could resist a "critical wind velocity of infinity" without so much as a twist or ripple along its 3,800-foot roadway. His theories were proved out in scale-model wind tunnel tests of "Mighty Mac."

The designer of the Verrazano-Narrows, the late Othmar H. Ammann, used another method to assure the stability of his structure: He made it too heavy for any wind to budge. Each of the 693-foot towers weighs 27,000 tons. The suspension cables weigh 38,290 tons. The roadway, plus cables and towers, add up to a vertical load of 135,000 tons at each tower's base.

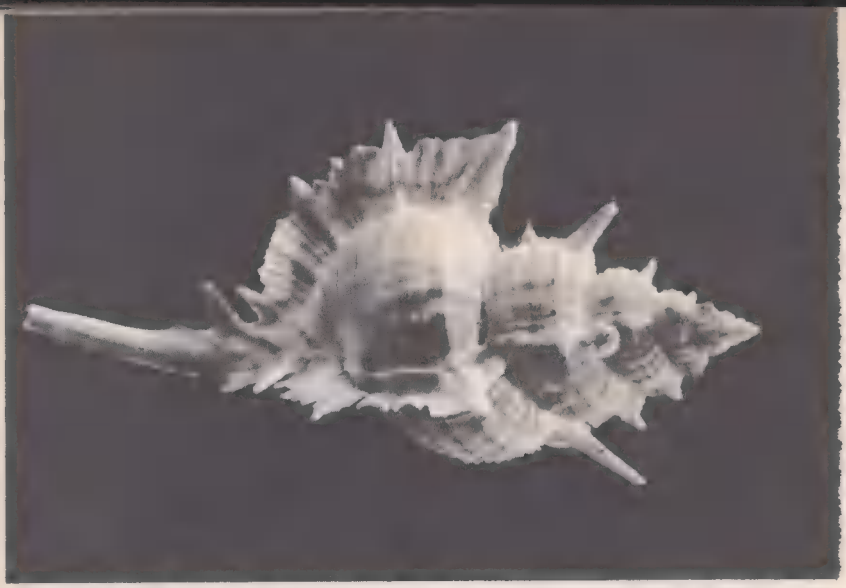
Besides the sheer weight of the bridge which immobilizes it against wind pressure, the roadway is designed to 'bow out' 14 feet at its center under the blast of a broadside hurricane. Like a skyscraper, the Verrazano has a built-in sway to absorb the push of the wind.

Center spans of 10,000 feet

Suspension bridges with center spans 10,000 feet long are possible, builders say, using today's engineering knowledge and building materials. (Possible locations: across Italy's Strait of Messina, Turkey's Bosporous and New York's Long Island Sound.) Designers use computers to calculate wind pressure on their vast, exposed flanks and to assure these super bridges of aerodynamic stability.

The Tacoma Bridge was rebuilt after World War II. The same cables were used and the same towers. Engineers eliminated flexibility in the roadway by making it 50 percent heavier. For the treacherous plate girders, they substituted open trusses 33 feet deep.

The fall of "Galloping Gertie" was a major engineering disaster 25 years ago. But from it, engineers learned to design bridges able to shrug off the fiercest winds nature can hurl against them.



One highly-prized sea shell is the Beau's Murex. This specimen was found off the coast of Cuba and is displayed at the American Museum of Natural History, New York.

The wonderful world of shells

by R. Tucker Abbott

WITHIN a few hours of the surrender of the Japanese Imperial Armed Forces in August, 1945, General MacArthur's headquarters received its first direct communication from His Royal Highness, Emperor Hirohito, "How is the health of my conchological friend, Dr. Henry A. Pilsbry?" Seashell-ignorant naval officers relayed the question back to Washington, where the U.S. Department of State came up with the answer. Dr. Pilsbry, 82-year-old curator of shells at the Academy of Natural Sciences in Philadelphia, was in excellent health, and had just published his 1,100th paper on mollusks.

The ice-breaking request for personal information, after so many years of fury and contest, was a symbol of the respect and international friendship existing between students of conchology. The bond

of common interest, whether it be between a shell-collecting Emperor and a scientist, or soldier and schoolmaster, has existed for centuries among those who have collected and studied shells.

Conchology, the study of shells, is known in France as "La Belle Science," in Japan as the "Emperor's Science," and throughout the English-speaking world as the "Queen of the Natural Sciences." Kings, emperors and dukes have succumbed to its spell; philosophers, monks and masons have written volumes on the subject; modern oceanographers and medical researchers delve into its secrets, and thousands of ardent shell collectors have organized themselves into shell clubs throughout the world.

On another occasion during World War II, a rare shell, used as a calling card, saved the life of a world-renowned Philippine shell collector. Pedro de Mesa, schoolteacher for years on Mindoro Island, had collected and exchanged shells with all the leading conchologists in the world. Among his shell collecting acquaintances was Dr. Tokubei Kuroda of Japan. When the Japanese occupied the Philippines in 1942, Dr. Kuroda sent Pedro de Mesa a specimen of Japan's rarest shell, the Miraculous Thatcheria shell, and with it a note asking if he would take over the care of the national shell collection in Manila. Patriotic de Mesa, instead, chose to flee with his family into the hills, where he carried on his fight against the invaders by aiding the guerrilla forces. In 1944, Japanese patrols caught up with him. It happened that the Japanese commander, General Kuroda, was a cousin of the conchologist, Dr. Tokubei Kuroda. When de Mesa produced the rare Japanese shell and the note, he was immediately released.

Before the dawn of civilization, man was an ardent shell collector. In the caves of Cro-Magnon man in France, estimated to be 25,000 years old, specimens of shells have been unearthed that come only from the Indian Ocean. Trading of Persian Gulf shells took the Cowrie shells into northern Turkey and Germany long before the Egyptian pyramids were built. The greatest traders of the Ancient World were the Phoenicians, who often travelled to England and sailed around the continent of Africa as early as 1,000 B.C. One of the secrets of their success was the monopoly they developed in a purple dye, Royal Tyrian, which they obtained from certain kinds of seashells.

The earliest formal research in conchology was done by the Greek philosopher and naturalist, Aristotle, who wrote an extensive account of mollusks in 336 B.C.

During Roman times there was less interest in shell collecting, although the conchological hobbies of the two generals, Scipio Africanus and Caius Laelius, are well-known.

Dr. R. Tucker Abbott of the Academy of Natural Sciences in Philadelphia is a malacologist and author of *Caribbean Seashells* and *Sea Shells of the World.*

Jay Sacks

For centuries Italian artisians have carved cameos, elaborate profiles of beautiful women, on the hard surface of the Bull-Mouth Helmet Shell from the Indian Ocean.

Between military campaigns, they vacationed at the seashore in Sicily and amused themselves by building up a collection of marine shells. About the year 77 A.D., Pliny the Elder issued his 37-volume "Naturural History" encyclopedia, which contains many sections about mollusks. Pliny was the leading light in the Natural History Society at Pompeii, where in 79 A.D., he was killed while trying to help refugees escape from the erupting Mount Vesuvius. Ashes completely smothered the city, and it was not until seventeen centuries later that a fabulous shell collection, containing specimens from all parts of the Ancient World, was unearthed by archaeologists. Could this have been Pliny's collection?

During the Middle Ages, conchology, like other sciences, was all but forgotten, but two developments heralded an awakening interest in shells. The navigator's compass made possible the voyages of Columbus, Diaz and Magellan. Shells were among the spoils and souvenirs brought back by these explorers. About 1440, the printing press appeared in Europe, and by 1480 books with woodcuts of shells were depicting the conchological treasures

Jay Sacks

The six-inch-long Giant African Snail was introduced accidentally to many tropical areas of Asia where it causes severe crop loss. The pea-sized eggs are hard, yellow.

of the royal courts. The leading accumulators of exotic shells were the Dutch, Spanish and English, each bent on expanding their empires and tapping the natural resources of the undiscovered world. Champions of the English shell-collecting explorers were the buccaneer, William Dampier, and Captain James Cook, discoverer of the Hawaiian Islands. Some of the shells they brought back are still in the British Museum of Natural History.

Today, the quest for shells continues. Dr. William J. Clench, head of Harvard University's mollusk research center, has made scientific collections in over 2,200 localities throughout his forty years of worldwide search for new specimens. His latest forays have been to the rivers of Florida and Georgia to obtain Unio mussels before increasing industrial pollution wipes out the native fauna. Dr. Clench has reconstructed the geological history of this part of the United States on the basis of his studies of the migration and distribution of these lowly fresh-water mussels. Dr. Clench says, "Already many dozens of species of land and freshwater mollusks have become exterminated by the advances of industrialization.

Jay Sacks

Seashore pleasures were depicted on the frontispiece of "Recreation of the Eye and Mind," first book on conchology, in 1681.

American Museum of Natural History

Phoenicians extracted the famous ancient dye, Royal Tyrian Purple, from the soft-bodied snail that built this spiny Murex.

These tropical snails, no bigger than appleseeds, carry schistosomiasis, a fatal parasitic disease affecting about 200 million Chinese, Egyptians and Puerto Ricans.

Jay Sacks

Unless man-made pollution is brought under control, most of our native river snails will become extinct. Unbalance nature, and our valuable food and sport fish will disappear."

One of the country's most active institutions searching for marine shells is located in Philadelphia, Pa., where the Academy of Natural Sciences sponsors privately financed expeditions to the far reef corners of the world. Established in 1812, this natural history museum has sent out over 100 expeditions for shells.

Instigator and driving force behind recent expeditions has been Alfred J. Ostheimer, 3rd, a successful insurance man whose avocation is conchology. An expert shell collector, Ostheimer has brought back tons of conchological treasures which now serve as the basis for scientific monographs being published by Academy scientists.

The dream of all shell collectors, whether they are on a shell safari for a scientific institution or out collecting for themselves, is to stumble upon a specimen of the rare Glory-of-the-Seas Cone shell. This beautifully decorated and gracefully conic shell, about five inches in length, is known from only a few specimens, most of which have come from New Guinea and the Philippines. In 1963, a good specimen was sold for $2,000. The same year, a Spotted Cowrie (*Cypraea guttata*) brought $1,000. Other rare shells, like the Golden Cowrie of Fiji, Adanson's *Pleurotomaria* of the West Indies, or Lister's Couch of the Bay of Bengal, bring several hundred dollars on today's active shell market. Van Nostrand's *Standard Catalog of Shells* is one of the main guides to values of thousands of species.

Although conchology has always appealed to hobbyists and collectors of rarities, its worthwhile contributions have been to other sciences, such as medical research, oceanography and geology. The lives of thousands of Egyptians, West Indians and Asians have been saved by efforts of medical workers who control the deadly parasitic diseases carried by certain fresh-water snails in the tropics. Conchologists, like Father Heude of China and Consul Schumacher of Canton, laid the framework in the nineteenth century for today's medical solution to one of the worst disease scourges of today, schistosomiasis.

In agriculture, conchology has played an interesting role in the control of the Giant African Snail which once plagued the rubber plantations and vegetable crops of the East Indies. Small African carnivorous snails were released in the Marianas Islands of the U.S. Trust Territory in a moderately successful attempt to control the giant vegetarian.

The most destructive of all mollusks is the dreaded Shipworm, *Teredo*, which, until the advent of steel-hulled vessels, usually ended the life of any wooden ship. In 1922, piers and warehouses worth millions of dollars slid into San Fran-

Jay Sacks

Miraculous Thatcheria shell patterns have inspired Oriental art for many centuries.

Jay Sacks

The four-inch-long Golden Cowrie entices buyers with its rarity, rich orange color.

cisco Bay, because of the undermining borings of this worm-like clam. Studies by conchologists proved that an increase in salinity, brought about by droughts and shrinking rivers in the Bay area, caused the unusual invasion by these marine clams. The Office of Naval Research still grants research money towards the solution of this vexing problem, and even the American Telephone and Telegraph Company is trying to prevent boring clams from destroying their underwater, lead-encased cables.

The seventeenth century conchologists, who were often physicians such as Martin Lister, physician to Queen Anne, and Walter Charlton, physician to Charles I and II, would have been overjoyed to learn of the recent discoveries of Drs. Benjamin Prescott and C. P. Li of the National Institutes of Health. These modern medical research workers have discovered through careful experiments that the raw body juices of the abalone snail of California will kill streptococcus and penicillin-resistant strains of staphylococcus microbes, as well as typhoid and paratyphoids. Mice infected with fatal poliomyelitis had their death and paralysis rate reduced 50 percent when orally fed abalone juice.

Although not yet clinically tested, natural juices of certain marine snails and clams hold great medicinal promise.

Quite in another medical light, conchology has been frequently used as a valuable form of occupational therapy and a helpful adjunct to psychotherapy. The idea was first proposed by the Italian physician, Filippo Buonanni, who published a colorful book in 1681, entitled, *The Recreation of the Eyes and of the Mind through the Observation of Shells*. The modern proponent was the late Dr. Merrill Moore, director of Boston's Washingtonian Hospital, who wrote, "I have found that certain tired, nervous and discouraged patients can find relaxation, recreation and enjoyment in collecting and studying shells. Every sick child should be offered a box of shells to play with and should be given some instruction or a simple book to explain them." He even recommended the hobby to his overworked colleagues in psychiatry!

The coming frontiers in conchology, however, are in the realm of oceanography. Mollusks are among the most abundant animals of our seas, and there are more varieties than all of the known worms, corals and other invertebrates. Scientists searching for new sources of proteins and for an understanding of the migrations of clam-eating fish, are now turning to the task of mapping the distribution of the sea snails and clams.

Meanwhile, legions of "shell-shocked" earthlings are enjoying their conchological searches and are contributing to the advancement of the "Queen of the Natural Sciences."

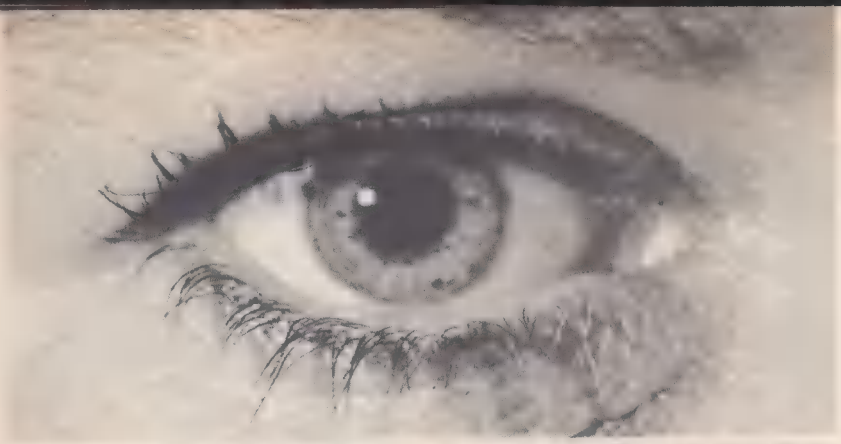
Workshop tools, animal style

HAMMERING and painting require tools, so wasps and otters, among other animals, have invented their own. A wasp of the *Ammophila* genus provisions his burrow, then plugs the opening with loose dirt. The covering is tapped firm by a bit of wood or a tiny pebble grasped in the wasp's jaws.

Dive-bombing is a war tactic of the black-breasted buzzard of Australia in emu nest raids. A stone is carried aloft and hurdled into a clutch of leathery eggs.

The satin bowerbird of Australia paints its bower with a bark wad held in its beak. The formula for the paint: charcoal, shredded bark, saliva.

California sea otters forage off the coastal seabeds for crabs, urchins, mussels and abalones. An otter hauls up a rock about five inches in diameter, puts it on his chest as an anvil, grasps the mussel in both paws and bangs it on the stone until the shell breaks. Not only do otters use tools, but they have been observed stashing the stone under their armpits while they dive and collect other mussels, according to K. R. L. Hall of Britain's Bristol University. The otter is the only non-primate mammal known to use tools to obtain food.



American Museum of Natural History

Odd tricks of the human eye

by Paul Brock

IT IS EASIER for the human eye to move from left to right than from right to left. If you doubt this, stand in front of a wall where pictures of about the same size and color are hung, and see if your eyes do not instinctively begin at the left and travel towards the right.

Now, examine any one picture, and if you don't look first at the left portion of it you are an exception, or the picture itself is exceptional.

English landscape painter John Constable once said that it is doubtful if many artists consciously knew this trick, but they must know it unconsciously, for most pictures have the chief point of interest at the left, or else the movement of lines begins at the left.

You may think that your eyes have formed this left to right habit through reading from left to right. But that is putting the cart before the horse. You do not instinctively look from left to right because you read that way; you read that way because you instinctively look from left to right.

With only a few exceptions all our written languages are read from the left. And there is a good explanation to account for those in reverse.

Chinese and Japanese are the striking examples of right to left movement. The reason is simple. Japanese and Chinese writing is done with a delicate brush, held almost upright in the hand. With this brush held in the right hand it is easier to make marks from the right to the left. When the Japan-

ese and Chinese began to print, they followed the same method, because people were accustomed to it.

Most people enter a building—a church for example—and will go to the right side. Most shoppers entering a store move from the center right.

Eyes like certain angles better than others. Consider a right angle, an acute angle and an obtuse angle. Which is the most pleasing to you? Probably you like the right angle least. That preference results from an instinctive sense of proportion. The right angle suggests equal parts, and equal parts are not as pleasing to the eye as proportionate unequal parts.

The eye also seems to prefer a line divided in a three-to-five ratio. McGill University studies revealed that we have a tendency to impose some sort of rigid pattern on our sight. Thus, the human eye does not like one part of a line to be, say, four times as long as the other part.

Symmetry

Sometimes, however, our eyes prefer symmetry and are satisfied by nothing else. We want a person's two arms to be of the same length, eyes of the same size, and we would object to one ear's being three-fifths the size of the other.

But while we want this symmetrical arrangement of duplicate features and members, we still seek proportion between the different sections of the body. Imagine a human figure in which the head, the trunk, and the legs—from hip to knee and from knee to ankle—were of the same length.

Three to five

We recognize this instinctive love of certain proportions when we say that some people's legs are "too long for their body," or their shoulders are "too broad for their height."

The proportion of three to five is what Constable called "the golden mean," and you will find it employed over and over again in art. Some painters actually measure the sections of their pictures on the canvas before they begin to paint.

Study a picture composed of land, sea and sky. Nine out of ten times you will find that the sky is either three-eighths or five-eighths of the picture, probably the former. And you will find that the land and the sea are also divided in the same proportion of three to five.

We think we look here and look there quite by chance, but this is not so. Eye specialists can tell you in advance just the route your eyes are going to travel.

For instance, when you are about to enter a strange room the first thing you see is the floor—that's right, the floor, although you probably are not conscious of it.

If, just on the threshold, someone should instantly stop you, make you close your eyes and ask you whether the room has wall-to-wall carpeting, or is spread with rugs, or has a hardwood or a tiled floor, you can usually give the right answer

even if you haven't yet set foot in the room.

To explain this, says an optical training report compiled by the U.S. Army Medical Research Command, we must take into consideration the many centuries during which we have been learning to "watch our step." Our forefathers did it in the jungle, caves, mountains, and we have been doing it ever since. As we walk along the street we think we are looking at a hundred things. But the eyes are always, without our consciously knowing it, keeping tabs on the way before our feet.

Among soldiers, the men hardest to train to march are mountaineers and woodsmen. A soldier is supposed to march with head up and eyes looking straight ahead. But the man who is used to rough country instinctively looks down to see where he is putting his feet.

The various layers of the human eye are clearly shown in this structural model.
American Museum of Natural History

Unless something distracts your attention, your glance when you enter a strange room will begin at the floor and then travel upwards and to the right.

There is another interesting point about our tendency to look to the left—in testing vision eye doctors at the University of Chicago find that most people not only begin looking at the left, but that the eye exaggerates the left portion of what it sees.

Upward motion

Which do you find easier to look at—a pyramid standing on its base or one standing on its apex? The first, of course, because the eye wants to move upward from the base to the peak, not downward.

It can be easily proven that the human eye doesn't always see things as they are. New York color psychologist Howard Ketcham, who has been influencing human behavior with color for a quarter of a century, recommends that we take some sheets of paper or some pieces of fabric of different colors—red, yellow, blue, green, black and white. Now cut some grey paper into strips and lay a piece on each of the colored sheets. In spite of the fact that we know all the grey strips to be exactly of the same shade, no two of them will appear alike.

When we look at the red sheet, for instance, the dominating idea is our "mind's eye" is of red, and the shock of not finding red when

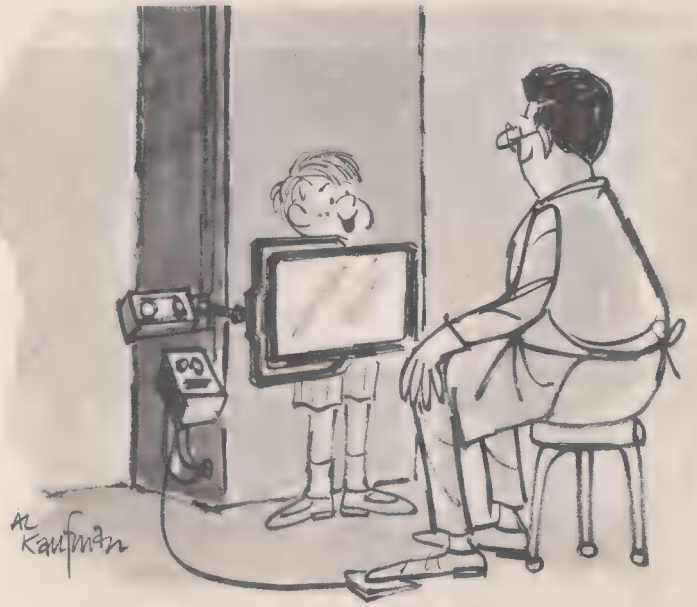
we look at the grey strip causes a rebound of sensation. Because we expected red, the grey looks even less red than it is. It goes to the opposite extreme and seems slightly greenish, green being the complimentary color of red. The grey strip on the green sheet looks slightly red. Each strip takes the opposite contrasting color to the underlaying sheet.

Of all the colors of the rainbow, bright red is the one which has the most drastic effect on our eyes, according to Ketcham. Through them red is capable of stimulating physical reaction, stirring passion and anger ("seeing red"), making us feel warmer and restless, and drawing the eyes inexorably towards it.

On the advice of an eye specialist a big oil company repainted many of its service stations. The only spot of red allowed was on the pump for the premium grade of gasoline. Sales of the higher grade fuel went up a staggering 60 percent.

At Purdue and Louisiana State universities other colors were evaluated by noting human reactions to them. Blue and green suggested security, tenderness and calmness. Black suggested distress, despondency and also defiance. Brown connoted protection; purple indicated dignity, yellow a cheerful mood.

Orange, oddly enough, seemed to be one color that had little emotional context for any of the persons taking part in the study.



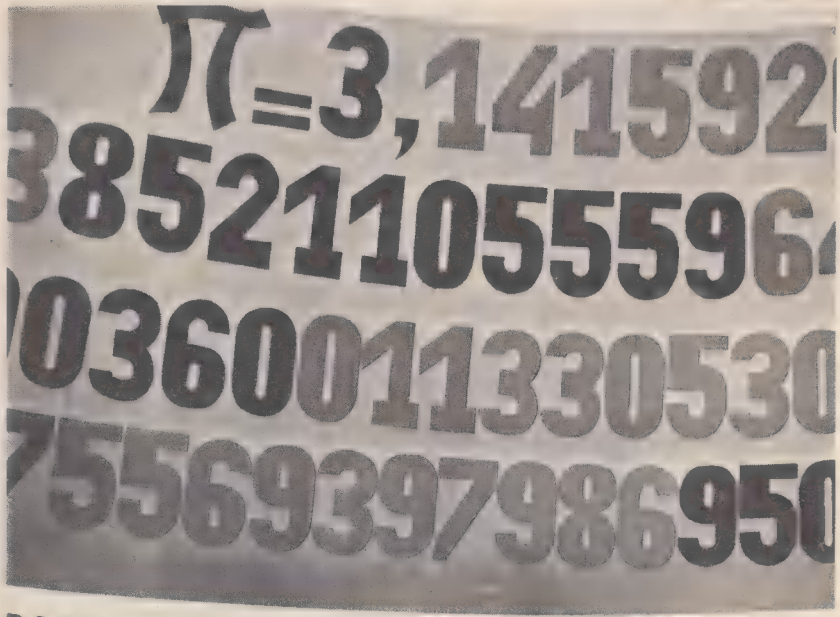
"What channel am I?"

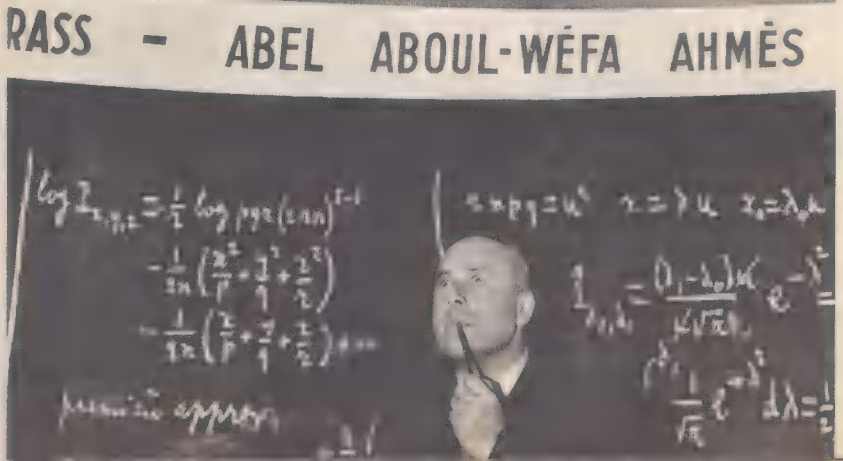
Math museum

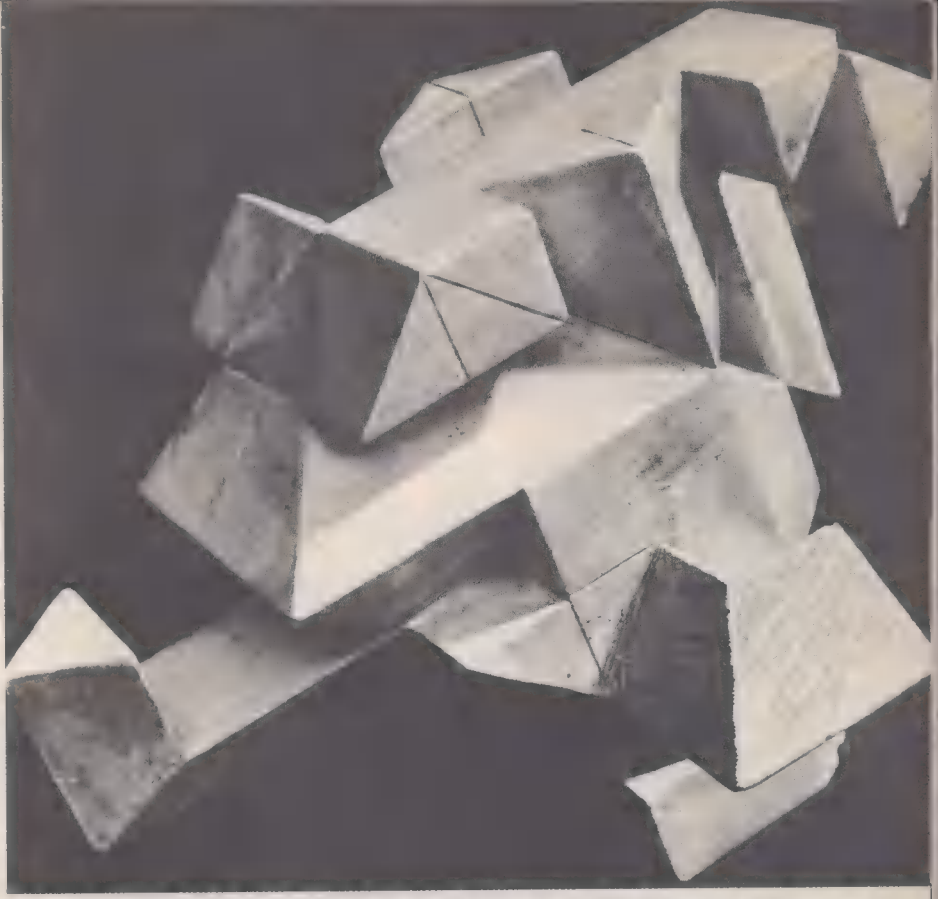
MATHEMATICIANS often wax lyrical over some of their concepts, describing them as "elegant" or "beautiful." To laymen such descriptions are meaningless, but they can get an insight into the artistry of math in the Hall of Mathematics of the Palace of Discoveries in Paris, where graceful models represent complex laws and principles.

The Dome of the Hall of Mathematics is encircled with the formula for the symbol "pi."

all photos Three Lions

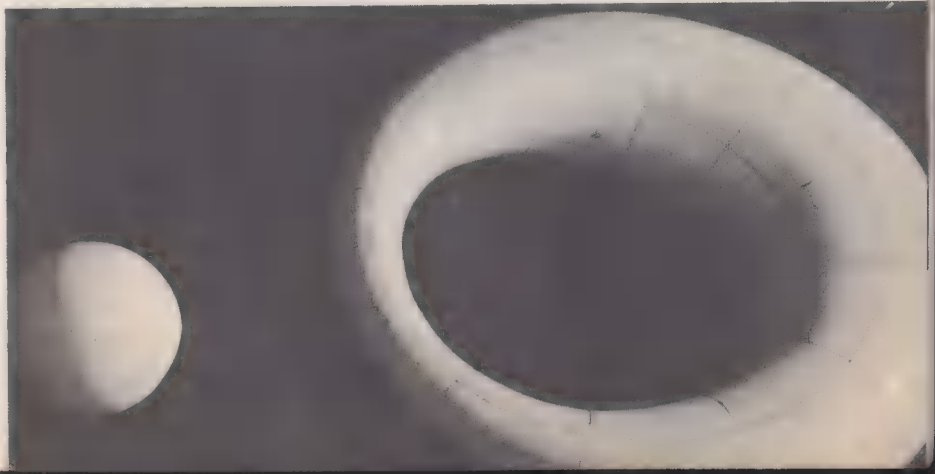


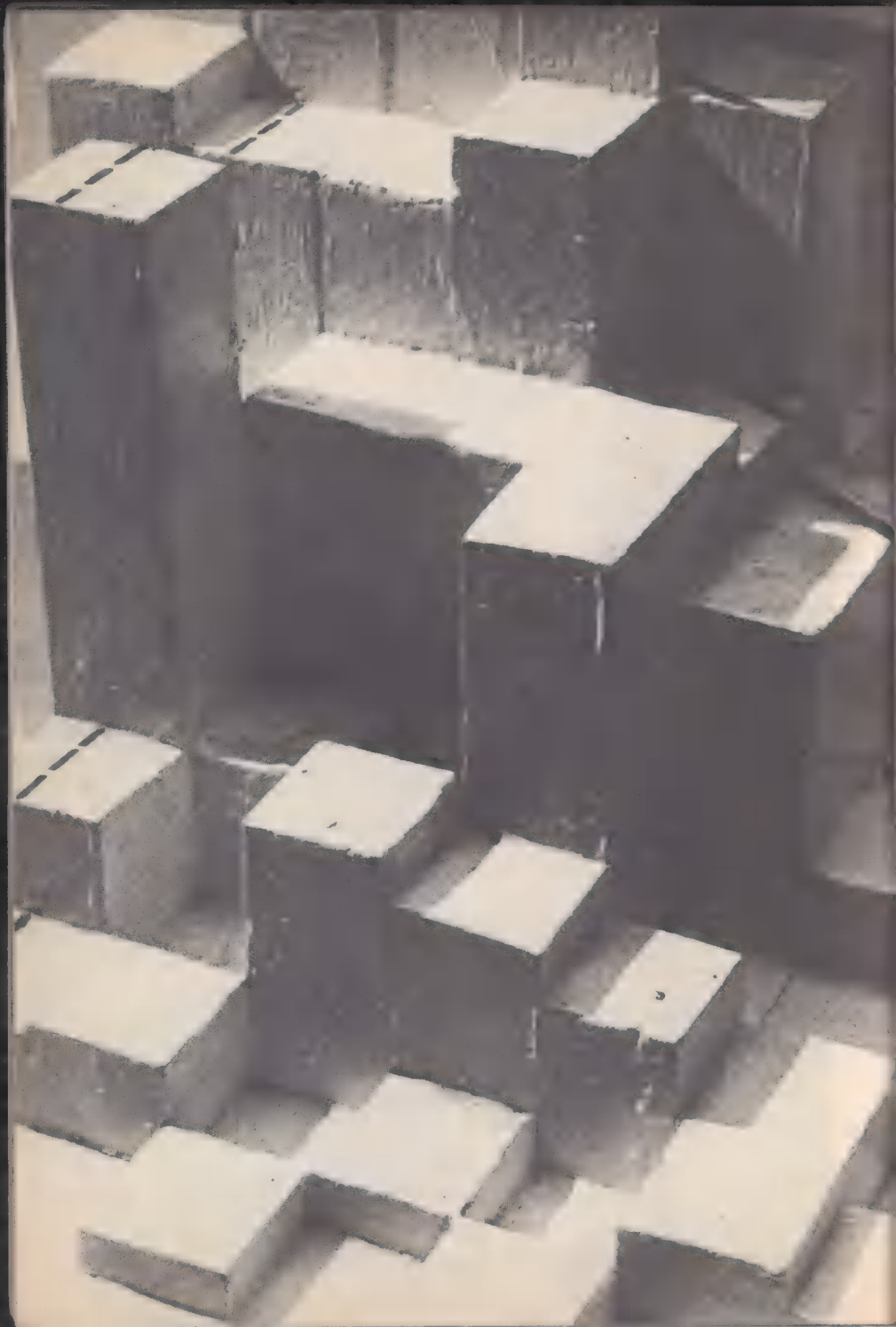




Not modern sculpture, but a strict mathematical principle, this surface shows curve construction rendering clear space division. Models are used to illustrate lectures.

These two works most closely resemble an orange and a lopsided doughnut. They are actually representations of two basic mathematical bodies, the sphere and the todoid.

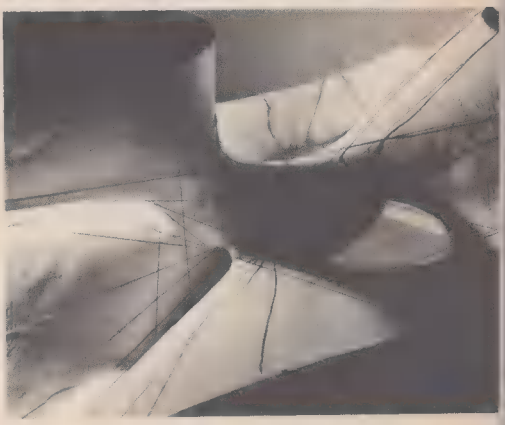




Above: Vertices forming Cassini's surface.

Left: Not a design for a new housing project but a three-dimensional realization of Galton's empirical theory, which deals with the height of sons and their fathers.

Plücker's conoid is a theorem involving movement of straight lines in space. In the museum this mathematical abstraction has been converted in a model into a form of surprising grace and beauty.



To the mathematician this curious model of plaster and wire illustrates a cubic surface on which 27 real straight lines exist.

COMMENT

Panic in modern man

Today's scientific society needs a new ethic to replace the old, says the man who started the two-cultures debate, even before C. P. Snow. He analyzed our plight earlier this year in a series of four lectures at the American Museum of Natural History, later broadcast over New York's WBAI-FM. The lectures are now a book. Here is a graphic excerpt.

by J. Bronowski

SOCIETY pays a price for the multitude of its loyalties. Each of them fosters its own set of values, and we have failed so far to knit these into one set.

For example, our society pays lip service to the value of scientific evidence, but cannot persuade people by any show of statistics that the death penalty does not discourage murder.

This is not because murder outrages their humanity, but on the contrary because it throws doubt on it. They catch in themselves the gales of rage, the hatred of a nagging mate, and the soft urge to poison a rival; and their revulsion for the murderer is also their fear of that glimpse in the dark mirror.

Here is the leading edge of panic in modern man which drags his society after him. It is his failure to make a unity of, as it were to make head or tail of, two sets of values. On one side, he is taught to take as his own a rag-bag of second-hand traditions about human motives that are out of date. And on the other, he is harried to treat as gospel (a new gospel) the newsworthy speculations of scientists whose context he does not know. No wonder that he listens to them with the mulish suspicion of a jury hearing expert evidence at the trail of a psychopath.

This double vision of the conscience will not be cured by adding a rapid course in biology to the school curriculum. It has been natural in the debate around the Two Cultures to treat the division between them as an issue in education; but it has been a fault, and I confess my share in it. This has

made it seem that science and literature are bundles of knowledge, and that all we need do is to swap them about more.

It is not accidental that Western man, with his strong sense of individual personality, expresses himself in science and literature together. The one is not a technique and the other is not an entertainment, and neither is a bundle of knowledge. They fix two modes of knowledge which are complementary, and which necessarily flourish and wither together. Seen in this way, the breach between them is not merely a gap in contemporary education, but is the visible sign of a loss of confidence in the identity of man.

It is possible to create again a coherent philosophy of man, and not by denying but by accepting the relevance of modern science. And neither must we deny the relevance of art (of modern art) which, for simplicity, I have illustrated in literature. Lord Cherwell used to recount that the wife of the Warden of All Souls said to him when he was a young professor of physics at Oxford, "My husband says that a man who has got a First in Greats could get up science in a fortnight." The Warden of All Souls must have been a silly man; but so is the young professor of physics (I meet him from time to time) who thinks that any good scientist could get up culture in a fortnight.

Art and science are the man-made monuments in which our past culture is fixed, and they are also the sensitive probes which signal the direction of its future. Meanwhile, the broad and present culture of the everyday tries dispiritedly to think where to put modern science—and, for that matter, modern art. It grumbles that science has disrupted morality, because it has freed human behavior from the ancient sanctions of fear and conformity. It protests that the arts are scandalous because the women do not have the look of Renoir and the manners of Oscar Wilde that scandalized our grandparents.

Behind the white page

The virtues and vices that the characters in literature display are as familiar to us as our own. They are our own; they come directly from the world that sits facing us behind the white page, waiting for us to shut the book.

But love is not the only pattern of virtue, and hate is not the only vice. There is another set of virtues which is founded on the central value of truth, and which is denied when truth is denied. But somehow falsehood (and even deception) does not have the personal air of outrage that, say, disloyalty has; perhaps, we say, it is only an error. We are willing to treat a lie in private life as an act of kindness, and in public life as an act of policy.

Excerpted from the book *The Identity of Man* by J. Bronowski. Copyright © 1965 by J. Bronowski. Published by Natural History Press, a division of Doubleday & Company, Inc.

The process of discovery is more important than any discovery.

The values that derive from truth are as old as our civilization. But they have been less critical in the past than they are now because there was not then a strong body of formal knowledge to set an example of truth. We have now seen science in search of truth give us an immense command in the affairs of nature, and we wonder whether we are wise to go on slighting it in our affairs of state. This is the uneasiness that haunts us whenever we dismiss the ethical implications of science.

Firmly directed

It is commonly said that science is ethically neutral, because its discoveries can be used for good or ill. This judgement confuses two meanings of the word 'science': the process of discovery, and what is discovered at the end of it. Of course what is discovered is neutral, whether it is Hooke's law, or a semi-conductor, or the theory of evolution. But the long and dedicated activity of the men who made these discoveries was not neutral: it was firmly directed and strictly judged.

In practicing science, we accept from the outset an end which is laid down for us. The end of science is to discover what is true about the world. The activity of science is directed to seek the truth, and it is judged by that criterion. We can practice science only if we value the truth.

But a culture must also have values which resist change. In engineering terms, it must have a certain inertia, by which it sustains what it holds to be true now, and makes the truth of tomorrow's fight for life. In order to be stable, the culture of science must give honor to those whose work is superseded as well as to the newcomer. It must treat the truth of the past, and the men who found it, with dignity. It must respect the man's way of working more than what he finds, because the process of discovery is more important to it than any discovery.

A just ethic must be grounded in a single-minded philosophy. And that must grasp that the identity of man derives from the coming together of two modes of experience, and is fixed in two modes of knowledge: knowledge of the physical world, and knowledge of self. It is not possible to make a modern structure of values which belittles either mode. A soundly based ethic begins in the action of understanding both nature and man. And scientific understanding is part of that: the choice between good and evil must not fly in the face of the choice between true and false.

But, of course, the matter goes deeper than that. What the scien-

tific mode has to teach the conscience is the code of values of science, which makes the pursuit of truth its first endeavor and an end in itself. Nothing erodes the public morality so much as the acquiescence in what is expedient when what is true is unpalatable.

Machine and self

Man is a machine by birth but a self by experience. And the special character of the self lies in its experience not of nature but of others. A man enters the lives of other men more directly than he can enter nature, because he recognizes his own thoughts and feelings in them; he learns to make theirs his own, and to find in himself a deeper self that has the features of all humanity. The knowledge of nature teaches him to act, and makes him master of the creation. The knowledge of self does not teach him to act but to be; it steeps him in the human predicament and the predicament of life; it makes him one with all the creatures.

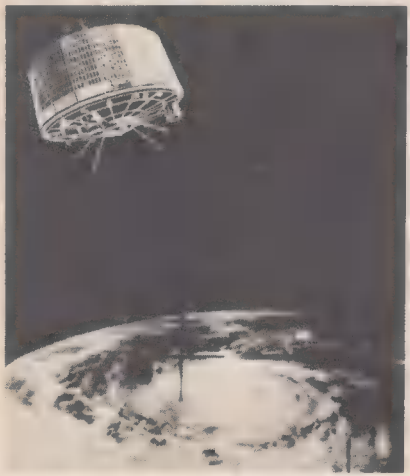
It is the tragedy of our age that we fear the machine in man, though it is as noble as the self; and we have grown to doubt whether it will leave us a self. We will not believe that what the machine learns and teaches, a knowledge of science, can strengthen our ethic, which now languishes among our random loyalties. Yet the search for knowledge in nature generates values as rich as we get by reaching for the knowledge of self. When we pursue knowledge for action we learn (among other things) a special respect for a man's work. And when we look into another man for knowledge of our selves, we learn a more intimate respect for him as a man. Our pride in man and nature together, in the nature of man, grows by this junction into a single sense: the sense of human dignity. The ethics of science and of self are linked in this value, and more than all our partial loyalties it gives a place and a hope to the universal identity of man.

Instant invoices

A computer-controlled communications network has been put to work as a robot attendant at two gasoline-loading terminals in Texas. It does almost everything but wipe the windshield. Here's how it works: A delivery salesman inserts two plastic code cards into a card-reader at the loading station. Loading pumps unlock and a Western Union teleprinter goes to work. It stores the salesman's name, billing information and the type and amount of gasoline pumped. The salesman takes out the cards, the pumps lock and the data is transmitted to a central Gulf Oil Corporation office. A computer processes the data and prints a complete invoice. The information is forwarded via teleprinter to another teleprinter at the pump. The salesman tears off his invoice within minutes and is ready to go.

PLEASE EXPLAIN

Where do 'dead' satellites go?



When power fails, satellites such as this Tiros weather watcher continue in orbit.

We all know of Mariner's epic photographic flight to Mars, but where will the Mariner gallop to now—Jupiter, Saturn—where? What of the other moon probes that missed their mark by a few thousand miles, as well as the Venus probe of some years ago? Do the scientists forget these satellites and merely chalk them off as interplanetary garbage?

Most satellites sent up by the U.S.A. and the U.S.S.R. have been placed in orbit about the Earth.

A satellite's orbit may, of course, intersect the Earth's surface so that it returns to the planet after a single looping upward thrust. The first two "sub-orbital" flights of the Mercury capsules were of this type. Sometimes a satellite's orbit makes such a large loop around the Earth that it gets beyond the Moon as well, as Lunik III did in taking pictures of the Moon's "other side."

If a satellite is sent upward at velocities of more than 7 miles per second, it will not be held by the Earth's gravitational field, but will move into an independent orbit about the Sun, which has a stronger gravitational field than Earth has and which can hold the faster-moving bodies. An around-the-Sun orbit may intersect the surface of some heavenly body as in the case of Rangers VII, VIII and IX which crashed into the Moon (on purpose, of course).

A satellite in orbit about the Sun may not intersect the surface of any heavenly body and it would then keep to its ellipse about the Sun indefinitely. The various "lunar probes" and "planetary probes" are of this variety.

Probes sent into orbit about the Sun can have their courses adjusted so that in the course of their first revolution they will make a close approach to the Moon (Pioneer IV), to Venus (Mariner II) or to Mars (Mariner IV). In the course of this approach, the probe will send back information concerning the body it passes and the space surrounding it. The probe will then move past the heavenly body and continue on its orbit about the Sun.

If the probes weren't affected by the gravitational field of the planet they passed, they would eventually return to the point in space from which they were launched (but the Earth would have moved on in its orbit in the meantime and would no longer be there).

As it is, however, the planetary probe moves into a new orbit as a result of the pull of the planet it passes. Indeed, its orbit shifts somewhat every time it passes fairly close to some massive body so that it is just about impossible to predict exactly where a particular probe will be after a revolution or two about the Sun. The equations representing their motions are entirely too complicated to be worth the bother of trying to solve.

Of course, if probes could continue to broadcast a signal they could be followed whatever their orbit—especially when close to the Earth. Mariner IV, for instance, may still be broadcasting in its next revolution.

Once the batteries on a probe die, however, the satellites are lost. They can't signal, and they are too small to see. All probes previous to Mariner IV have long since been lost and that was to be expected.

They continue to follow orbits about the Sun, however, and remain in the same general regions of space. They do not wander off on long voyages to other planets. Since we receive no information from them, they are useless and can only be chalked off as "interplanetary garbage." If they don't blunder into the Earth, Moon, Mars or Venus in some future revolution about the Sun, they may well move on forever in orbit.—*Isaac Asimov*

I had always heard the thymus gland was a useless organ. But recently I have been told that scientists are studying it for a possible approach for a cancer cure. Why have scientists changed their minds?

The thymus is an enigmatic gland that lies beneath the breastbone over the upper part of the heart. For many years the function of this organ was a complete mystery and some scientists regarded it as an evolutionary hangover, with no particular use. The thymus had not always been held in such low regard, however. The Greeks believed it to be the seat of courage, possibly because it is at its largest during adolescence.

But today, the thymus, sometimes called the "sweetbread," is the subject of intense study in the United States, Europe and Australia. Further knowledge about the thymus is being eagerly sought because of the many likely applications it could hold for the treatment

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This new regular feature of *Science Digest* will attempt to answer questions about the how's and why's of science. Send your question to Please Explain, Science Digest, 1775 Broadway, New York, New York, 10019.

and prevention of disease—particularly cancer.

The thymus is now considered to have a key role in immunity against disease. High among its functions is the stimulation of the production of antibodies—substances that help the animal organism to repel invasion by bacteria and viruses.

During the 1940's research workers established that the thymus was responsible for stocking the body with cells of a very special kind called lymphocytes, which have the ability to travel freely through the body and are more abundant than any of the body's wandering cells.

When these cells are liberated into the circulation, they settle down in organs like the spleen. Here they give rise to the cells responsible for some or perhaps all the immunological functions of the body. But while the thymus appears to be the starting point for defense against disease, a disordered thymus appears to be the starting point of other diseases, particularly those known as autoimmune diseases.

Autoimmune diseases are those conditions in which cells or tissues of the body seem to be attacked by antibodies or by the cells stimulated by the thymus. Rheumatoid arthritis and possibly multiple sclerosis are examples.

According to Australia's Dr. Gustav Nossal, "perhaps the most important aspect of the thymus will be its role in our defense against cancer. It seems more than coincidental that cancer develops at a stage in later life when the thymus has shrunken and given up its function of recognizing newly-developing cancer cells in the body."

Dr. Nossal has predicted that if the function of the thymus could be strengthened a quite different approach to the problem of cancer would result. Experts on the thymus are convinced also, that the next step must be the isolation of the secretory product of the thymus. This product is not expected to be the elixir of life, but it will have remarkable properties which could enhance man's powers of immunity.—*D.C.*

What causes a severe earthquake and how is it measured?

Earthquakes are caused by movements within and under the crust of the earth. At least 100,000 quakes are recorded annually. Major earthquakes, however, result from breakups of rocks that have been strained. As the rocks are strained beyond their limit of elasticity, they rupture and snap back, releasing potential energy as seismic waves. As the rocks shift and strain, new positions may cause aftershocks until the rocks settle.

The magnitude of the quake in the U.S. is measured by seismograph records according to a scale, revised by Charles F. Richter, based on the Modified Mercalli scale.

The zero point on the Richter scale corresponds to the smallest quake. The type of seismograph and the distance from the quake to

the machine are specified on all readings. Logarithms are used to compute earthquake size.

Intensities began at number I. Human beings can't feel movement but dizziness or nausea may accompany the quake. Trees sway although no winds blow and chandeliers may swing.

Number II earthquakes may be felt by persons resting or on the upper floors of buildings. Number III feels like a light truck might be traveling past and outside effects are not noticed.

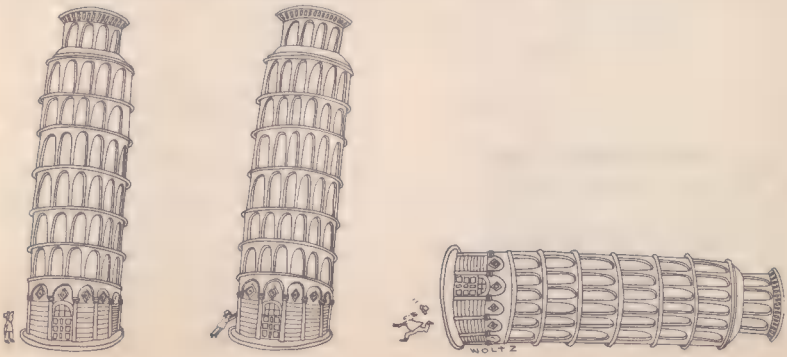
A Number IV intensity can cause standing automobiles to rock. Glasses clink, windows and doors rattle, indoor hanging objects swing. A Number V intensity quake is felt outdoors where the direction of the quake can be gauged. Inside buildings, sleepers awake, shutters and doors move, some liquids overturn and pendulum clocks are affected.

A quake of number VI intensity frightens people. Weak masonry and plaster crack, furniture may overturn and books fall from shelves. Small school bells ring and even shrubbery is visibly shaken.

A quake of number VII intensity makes standing difficult and will damage mediocre masonry. Sand and gravel banks cave in and irrigation ditches are ruined. Waves appear on ponds, water muddies.

Only the best masonry is not damaged in a number VIII quake. Automobiles are hard to control and towers may fall. Tree branches break; wells and springs become colder or hotter. Cracks show up on steep slopes. A quake of Number IX intensity is acute, causing general panic. Ordinary buildings are damaged and frame houses move off their foundations. Cracks in the ground are plainly visible.

Number X and XI quakes, are marked by destruction of dams, well-built bridges, embankments and rails bend slightly. Large hunks of land slide and water is thrown from lakes and streams. In a Number XI earthquake underground pipelines are completely ruined. In a number XII earthquake, solid rocks break by faulting and nearly total destruction covers the area.—*J.R.*



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KFS

Electricity and magnetism quiz

by John and Molly Daugherty

A BLANKET doesn't have to be electric to have electricity in it. Watch the sparks fly and hear them crackle when you throw aside the synthetic blanket that covers your wool one on a dry, cold night in December!

Can you answer these questions on electricity and its related phenomenon—magnetism?

1. A thermocouple consists of two dissimilar metals joined to complete an electrical circuit through a current-indicating galvanometer. If one of the junctions is heated, a small current flows through the series circuit. If you send a current through the thermocouple instead of heating one junction
   a. One junction of the dissimilar metals will be cooled and the other warmed.
   b. Nothing will happen except the normal heating of the circuit due to electrical resistance.
   c. Both junctions of the dissimilar metals will become warm and cancel the thermoelectrical currents.
2. A 10-inch piece of thread is tied to the head of a steel pin and the loose end of the thread fastened to a table. If you hold the pin up and suspend a strong magnet an inch above it, the magnet will hold the pin upright with an air gap between. Which insertion between pin and magnet is most likely to cause the pin to fall down?
   a. A piece of cardboard
   b. A sheet of copper
   c. A sheet of thin steel
3. Natural radioactive minerals give off

alpha, beta, and gamma rays. Radium is an example of a radioactive element. Which one of these rays is an electromagnetic wave instead of a charged particle?

a. Alpha
b. Beta
c. Gamma

4. When Edison put an extra metal electrode inside his evacuated light bulb and connected it to the positive side of a battery source, a galvanometer in the circuit showed that a current flowed. This circuit consisted of a flow of
   a. Positive and negative ions between the filament of the bulb and the electrode
   b. Positive charges (protons) from the electrode to the filament
   c. Electrons from the filament to the positive electrode
5. When a current flows through a wire, a magnetic field exists about the wire. The magnetic field is like
   a. Concentric circles perpendicular to the wire
   b. The spokes of a wheel radiating from the wire
   c. Expanding spirals perpendicular to the length of the wire
6. In electrolysis of liquids or molten solutions of electrolytes, there are no internal wires to carry the current from one electrode to the other to complete the circuit. The current is transmitted through the electrolyte (e.g., through a molten solution of sodium chloride) by
   a. Positive charges (protons)
   b. A two-way traffic of positive and negative ions
   c. Electrons, the same as in a metal conductor
7. Static charges of electricity are always at rest until a discharge occurs, as in lightning. If you rub a glass rod with silk, the glass rod becomes positively charged because
   a. Some positive charges pass from silk to rod
   b. Some electrons move from rod to silk
   c. Both positive and negative charges move until the condition is produced
8. Atoms of a naturally radioactive element like uranium emit alpha and beta particles in an ordered sequence. Uranium has an atomic weight of 238 and the atomic number of 92 (protons). When the uranium atom gives off one alpha particle with a charge of two protons, it becomes
   a. Element 90
   b. An isotope of uranium—still element 92
   c. Element 94
9. If the attraction of a magnet for a steel thumb tack has a certain value when it's a half-inch away, the effect of placing it a whole inch is that the force would
   a. Not change
   b. Be one-fourth as great
   c. Be one-half as great
10. If you place a small iron nail near the north pole of a magnet, the magnet will attract the nail. The explanation of this attraction on the basis of simple molecular magnetism is that
    a. The end of the nail nearer the magnet becomes a north pole like the magnet.
    b. Many of the molecules of the nail line up as little magnets in the same order as those of the magnet.
    c. No change occurs in the molecules of the nail.

Answers:

1—a One junction of the dissimilar metals will be cooled and the other warmed. This is the *Peltier effect* and is the inverse of the thermocouple being used to produce a small current by the use of heat. Although the cooling effect for one couple is small, when many are used it is possible to operate a small electric refrigerator on this principle. Some hotels install them in each room.

2—c A sheet of thin steel. Magnetism will pass right through the cardboard and the copper, as it will through most common materials. The magnetic lines of force will enter the sheet of steel, and the magnet will attract the steel and hold it fast to the magnet. The steel shields the pin from almost all magnetic influence, and the pin drops.

Radio and TV sets frequently use steel cans to shield tubes and other circuit parts from each other.

3—c Gamma rays. They are electromagnetic waves like light but invisible. They may be compared to X rays—sort of a super X ray. Alpha particles are helium ions—helium atoms which have lost two electrons to become charged plus. Beta particles are negatively charged and are electrons.

4—c Electrons from the filament to the positive electrode. The nature of the flow was not known till later when J. J. Thompson identified it as electrons (negative charges). This led to the development of radio tubes. The tiny flow of current may be increased millions of times when tungsten of the filament is alloyed with a small amount of thorium oxide. The flow of electrons from a heated filament is called thermionic emission.

5—a Concentric circles perpendicular to the wire. Lines of force are invisible, but you can visualize them in several different ways. You may place a tiny magnetic compass in the magnetic field. Its north pole will point the direction of the line, and successive movements of the compass enable you to plot the line. Or you may sprinkle iron filings on a cardboard which is perpendicular to the wire. If you tap the cardboard gently, the filings will line up in concentric circles.

6—b By a two-way traffic of positive and negative ions. In this case the ions are charged atoms. The molten sodium chloride ($NaCl$) supplies countless sodium ions (Na^+) and chlorine ions (Cl^-). When you connect the battery source to the pair of electrodes, one electrode receives a generous supply of electrons maintained by the battery, and it attracts the positive sodium ion. The sodium ion acquires an electron from the electrode, and the ion becomes an atom. Sodium collects on that electrode. The positive attracts negative chlorine ions, which become atoms by giving up the electron charge. Two atoms of chlorine produce a molecule of chlorine gas which escapes. Na^+ ions take electrons off the negative electrode, and Cl^- ions deliver electrons to the positive electrode.

7—b Some electrons move from rod to silk. Before you rub the rod with the silk, both materials are neutral—that is, there is a balance between the number of negative charges (electrons) and the positive charges (protons) on each. Only electrons can move to disturb the balance. As electrons pass to the silk, the rod is left with a deficiency of electrons and therefore shows a surplus of protons or a positive net charge. The silk becomes negative then because it has a negative surplus.

8—a Element 90 or thorium. This

change is natural transmutation. When the atom loses two protons from its nucleus, it becomes number 90, a different element in the periodic chart. Since the alpha particle carries four relative mass units, the resulting atom becomes an isotope of thorium with an atomic weight of 234 instead of the original 238.

9—b One-fourth as great. The strength of the magnetic field about the poles of a magnet drops rapidly as distance from the magnet increases. It varies inversely with the square of the distance. Thus if the distance is twice as great, the force of attraction is only one-fourth as great. If the distance is three times as great, the force is only one-ninth as great.

10—b Many of the molecules of the nail line up as little magnets. This line-up of the molecules in the nail induces a south pole in the nail end nearer the magnet and a north pole at the farther end. Therefore the magnet's north pole attracts the south pole of the nail. Unlike poles attract.

Score Yourself:

9—10 right—Your score should give you a charge!
4— 8 right—Not too electrifying a score.
0— 3 right—Magnetism hasn't attracted you before.

"Okay girls, that'll be all for today. Ten o'clock tomorrow morning."

Mars photos

I enjoyed the article and photos on Mars ("Obituary of a Planet," Oct. '65). Our own planet has areas that make life hardly bearable and from a distance, with an instrument like Mariner, it would be hard to make definite recordings.

ELMER J. BRASWELL, JR.
Atlanta, Ga.

LSD conference

We were very pleased with the coverage *Science Digest* gave to the Second International Conference on LSD and Psychotherapy ("How to Use LSD," "Inside Psychiatry Today," Aug. '65). It is gratifying also to see the coverage of other topics in psychiatry which *Science Digest* has each month, such as the one on marriage in the June '65 issue.

TRACY H. LOGAN, Comptroller
The Long Island Home, Ltd.
Amityville, N.Y.

Euthanasia

For many months I have been following the remarkable column "Inside Psychiatry Today." I have nothing but high praise for it. Now, with the article about mental retardation (Oct. '65), it stirs me to action.

I should like to see a controversy about whether or not the hopelessly retarded, those who cannot even care for themselves on the most elementary levels, should be allowed to live. Wouldn't it be more merciful to end their misery?

I am aware of the possible abuses, but a board of psychiatrists could pass judgment. Then euthanasia could follow. No mention of this was made in your article.

IRVING K. ROLLING
New York, N.Y.

Species of dinosaurs

In his otherwise satisfactory article "Were Dinosaurs a Failure?" (Sept. '65), Alan Smith in saying, "How many orders and sub-orders were there within the species of dinosaur?" committed an inexcusable error in use of the word 'species.'

The species is the kind of animal, the smallest unit. An order is a large taxonomic group. In a few animal classes, certain orders contain thousands of species.

The species fully named bears a binomial name, the species name preceded by the name of the genus to which it belongs. In some cases, because numerous species are hard to distinguish, the genus name alone is well known. In the case of dinosaurs it appears that the genera have not been classified down to differentiated species. The genus name is the adequate name for the kind.

Colbert's "The Dinosaur Book" (1945 edition) lists, not counting the order *Thecodontia,* ancestral to true dinosaurs, two orders of dinosaurs, *Seurischia,* in which 11 genera are grouped in two sub-orders, and *Ornithischia,* of 20 genera, grouped in

four sub-orders. Hence for practical purposes we can say that there were at least 31 species which comprised the two orders of dinosaurs.

WALTER C. KRAATZ, PH.D.
Akron, Ohio

Writer Smith was using the word "species" in its general, non-biological sense.—Ed.

In defense of 007

Your article "But Is It Science?" (Sept. '65) seems to reduce a James Bond novel to the standard of "The Man From UNCLE." I personally enjoy the UNCLE program and I don't mean to degrade it. What you say about fantastic gimmickry certainly applies to UNCLE. However, you state directly that "the Bond stories rely heavily on fantastic scientific gimmickry."

True, Fleming's stories are romantic, but far from fastastic. A nonexistent scientific device in them would be difficult to find. Note I do not mean this to apply to any Bond movie—for here we do truly get into the realm of fantasy.

I believe that the present craze for "secret agent" shows will die quickly. However when the craze is over, Fleming's novels will still stand as excellent literary works.

JOSEPH N. FADYN
Olyphant, Pa.

Sonar for the blind

Maybe if we weren't so busy admiring our cleverness, we would have time to look over some of the work that others have been doing. I refer to the article "How the Blind Use Sonar" (Sept. '65).

Big deal! Maybe some of these boys will be bright enough to contact England and find out what St. Dunstan's (the association for the blind) has been doing by way of this type of training for many years.

I have a blind friend who was trained at St. Dunstan's. By snapping his fingers and listening to the echoes, he was able to tell me the size, location, type of material and distance from him of every object in a room that he had never entered before.

JERRYL L. KEANE
South Norwalk, Conn.

How long IS a block?

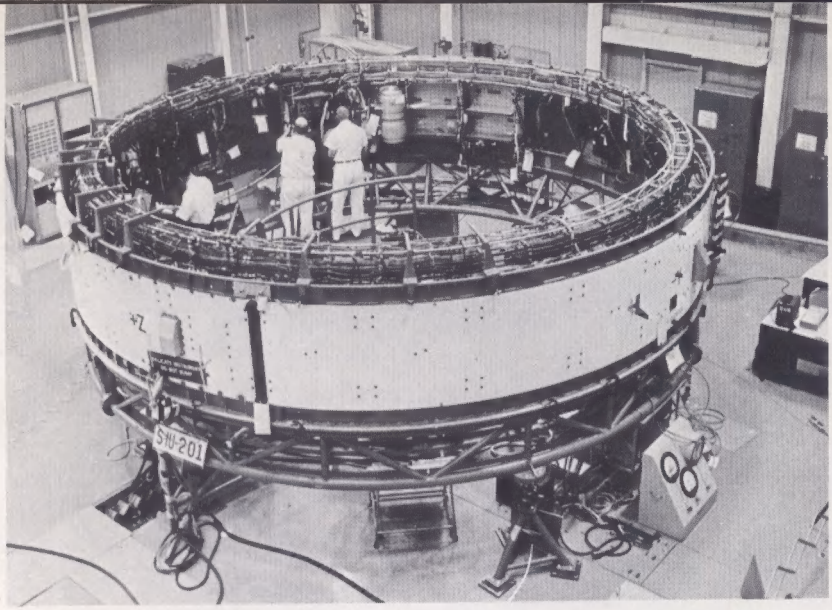
There is one special attribute of not only your magazine but almost all U.S. magazines which shows that the American layman cannot grasp simple measures of length, breadth and height. You usually write that a certain satellite is "ten stories high." Why not 100 feet (or still better, so many meters)? The lengths are usually mentioned in [numbers of] "blocks long."

By such expressions, foreigners might believe that Americans are still living in the Middle Ages when compared with the Russians. Moreever, readers like me don't know how long a "block" in the U.S. is.

How would you like the mention of dimensions of your magazine as 1/200th story high by 1/400th story broad and 1/5000th block thick?

MOHD ANWAR KHAN
Rawalpindi, West Pakistan

That is a 64-rupee question.—Ed.



All this will fly

WHEN America's largest space vehicle to date is sent up early in 1966, this 21.7-foot-diameter Instrument Unit or IU (above) will go up with it.

The gargantuan circle of wires and advanced electronic equipment will be the nerve center of the Saturn 1B, predecessor of the Saturn V that will put an American astronaut on the moon.

Actually, the IU has already completed the first leg of its trip into space. This was the slow and unspectacular week-long barge trip from Huntsville, Ala., to Cape Kennedy, Fla.

The unit is now being assembled with the Saturn 1B between the payload and the second propulsion stage. When the giant launch vehicle lifts off, the IU will navigate it; generate steering commands; control stage separation, engine shutdown and reignition and communicate the vehicle's position and other data to the ground.

On later flights, the IU will stabilize the S-1VB (second propulsion stage) and the Apollo spacecraft during the turnaround and docking maneuvers of the command module and the service module. On the Saturn V launch vehicle, which is destined to send astronauts toward the moon, the IU will put the spacecraft into lunar transfer trajectory before it separates.

International Business Machines Corp., under a $175 million contract with the National Aeronautics and Space Administration, will ultimately fabricate, assemble and test 27 IU's, 12 for the Saturn 1B and 15 for the larger Saturn V launch vehicles.

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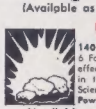

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